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THE UNIVERSITY OF ALBERTA

Impacts of Futures Prices on Canola Street Prices, 1983 to 1986

by

(C) Robert Earl Burden

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Science

IN

Agricultural Economics

Department of Rural Economy

EDMONTON, ALBERTA

Spring 1988

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Impacts of Futures Prices on Canola Street Prices, 1983 to 1986 submitted by Robert Earl Burden in partial fulfilment of the requirements for the degree of Master of Science in Agricultural Economics.

Michele Veeman

Supervisor

Date February 24 1988

DEDICATION

This thesis is dedicated to my mother and father. They taught me the value of a good education and the meaning of love.

ABSTRACT

The objective of this study is to examine the impact of futures prices on the establishment of canola street prices. This is accomplished by assessing the strength and direction of time ordered associations between daily futures prices for rapeseed, soybeans, soyoil and soymeal, and cash prices for canola between 1983 and 1986. Granger causal structure is identified using Geweke testing procedures. The Geweke approach uses ordinary least squares estimators to test for time ordered associations between various data series.

The estimated model results suggest interesting developments in lead-lag relationships between Winnipeg Commodity Exchange (W.C.E.) rapeseed futures contract prices and Alberta Wheat Pool (A.W.P.) canola street prices, as well as between Chicago Board of Trade (C.B.O.T.) futures contract prices for soybeans and products, and A.W.P. canola street prices. The statistical analysis performed on these price series suggests that prices of rapeseed futures contracts established on the W.C.E. tend to lead A.W.P. canola street price establishment in 1983 and 1984, but the two series seem to be determined instantaneously (that is, within one day) in 1985 and 1986. The diminishing time lag between the establishment of rapeseed futures prices and A.W.P. cash prices between 1983 and 1986 suggests increasing maturity and liquidity in the canola price determination process. Further, C.B.O.T. futures prices for soybeans, soyoil and soymeal, and A.W.P. canola street prices appear to have a significant instantaneous lead-lag relationship. Despite the significance of all three lead-lag relationships between soybeans, soyoil and soymeal, and A.W.P. canola street prices, there appears to be a stronger correlation between U.S. soyoil futures prices and Canadian canola street prices than between the other two price series. However, the lead-lag relationship between W.C.E. rapeseed futures prices and A.W.P. canola street prices seems to be relatively more significant than the lead-lag relationship between C.B.O.T. soyoil futures prices and A.W.P. canola street prices.

ACKNOWLEDGEMENTS

There are a number of people to whom I am deeply indebted for their friendship, knowledge and time during my two years as a graduate student in the Department of Rural Economy. I am most thankful to my advisor, Dr. Michele Veeman, not only for the countless hours of thorough analysis and numerous insightful comments concerning this thesis, but also for her moral support and encouragement. I am also very grateful to the other members of my committee, Wiktor Adamowicz, John Delahanty and Dr. J. Richter, chairman of my oral examination.

I would like to thank the Agricultural Research Council of Alberta for their financial support of this study, through the "Farming for the Future" funding program. Many thanks to Judy Boucher for her assistance in the typing and technical production of this document, saving me countless hours of work. Jim Copeland and Clare Shier were sources of endless knowledge concerning computing difficulties and data manipulation. Clare, Jim and Jim Lougheed should also be commended for their unfailing, unequivocal support of a pathetic hockey club floundering to its demise after a brief reign as Stanley Cup Champions (Ya gotta beleaf!!).

I would also like to express my appreciation to Barb Johnson, Hildegard Zeidler, Wendy Williamson and Holly Horvath for helping me find what could not be found and helping me smile when I didn't feel like it.

A special note of thanks goes to my office mates in 549, John, Marina, Louise, Brett and even Gurmit who provided endless hours of entertainment with his inept attempts at pool and darts. To my fellow yuccies, Don and Frank, as my grandfather used to say, "Thank goodness you left after my first year or I would never have finished." I leave with fond memories of Uncle Jack and Jake, supplied in whole or in part by Bill and Evelyn Phillips.

Finally, I sincerely thank Nan, Peggy and Douglas Matheson for becoming my second family at a time when I so desperately needed one. It is truly hard to leave.

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I. The Nature of the Inquiry

This thesis contains an examination of one aspect of the pricing mechanism for rapeseed/canola. Various econometric and related methodological procedures are used in the analysis of canola street price discovery. In the highly competitive world market for oilseeds, extensive knowledge of the components of price discovery are essential to the successful operations of producers and processors. It is hoped that the results from the study will aid market participants in analytically assessing available pricing information.

A. Introduction

In 1958 the Canadian Food and Drug Directorate approved the use of rapeseed oil for human consumption. Canola, which is the name given to improved cultivars of rapeseed with low levels of erucic acid and glucosinolate in its oil and meal respectively, has since become the basis for the Western Canadian oilseed industry.

Canola occupied approximately 2.8 million hectares of prairie land in 1986 when production was 3.9 million metric tonnes (Statistics Canada, 1987b).[1] Canola accounted for 682 million dollars in farm cash receipts in 1986; this represented 7.4 percent of all crop receipts and 3.3 percent of total cash farm receipts (Statistics Canada, 1987c).

The People's Republic of China is currently the world's largest canola producer followed by the European Economic Community (E.E.C.), and Canada. The latter two countries accounted for approximately 19 percent of world production in 1986. Canada was the world's largest exporter of canola, accounting for 41.5 percent of the world trade in unprocessed canola, 19 percent of world trade in canola meal and 13 percent of world trade in canola oil (based on data in Statistics Canada, 1986c, and USDA, 1986). Exports of processed and unprocessed canola comprised 7.3 percent of the total value of all Canadian agricultural commodity exports in 1986. Export sales of unprocessed canola were valued at 422 million dollars in 1986 while meal and oil sales contributed 56 million and 131 million dollars respectively (Agriculture Canada, 1987). Some 1.3 million tonnes of canola were crushed in

[1] In Canada, canola is grown almost exclusively in the prairie provinces.

1986. Increasing quantities of canola oil have been further refined and processed into margarine, salad, cooking and shortening oils; by 1986 canola accounted for 58.3 percent of all Canadian deodorized oil production (Adolphe) and for a large proportion of Canadian edible oil consumption.

It is evident from the value of canola production, export earnings and value added by canola crushing and further processing, that canola production and marketing is of major importance to prairie and Canadian agricultural systems. The crop also provides the benefits of crop diversification to western Canadian producers. Canada also plays the role of a leader in canola research and plant breeding. [2]

B. Justification and Problem Statement

The world market for oilseeds consists of many varied oilseeds from different producing regions located around the world. Each component of this complex system is directly influenced by its own specific and technical characteristics as well as by interrelationships with other oilseeds (Griffith and Meilke, 1980).

Price determination and marketing for canola are not regulated but are conducted in an open market although there are delivery quotas for the product. Futures prices are established on the Winnipeg Commodity Exchange and form the basis for cash or street prices for this product. A previous study concluded that there was evidence of a downward price bias in rapeseed futures prices over the initial ten years for which rapeseed futures were traded on the Winnipeg Commodity Exchange (Veeman and Moreau, 1987). Tests of pricing efficiency on data in the subsequent decade (1973-1983) suggested that there was no longer any evidence of consistent downward bias in the futures prices of this oilseed. Veeman and Moreau have suggested, however, that selective rather than routine hedging be undertaken by market participants due to the high price variability which is exhibited in this market. The

[2] Canada's image as the world leader in canola product development is a result of large research expenditures in the areas of crop production and product utilization. In 1987 the Canola Council of Canada had a budget of approximately 2.9 million dollars. A large majority of this budget was allocated to varietal development/plant breeding programs (Earl, 1987).

previous study of the pricing efficiency of the rapeseed futures market compared the performance of the rapeseed futures market with the Chicago Board of Trade futures market for soybeans over the period from 1979 to 1983. Tests of serial correlation of the first differenced series of log-transformed daily futures prices for the most heavily traded and the least heavily traded contract months were applied. There were periodic instances suggesting pricing inefficiency in both the rapeseed and soybean futures markets and these were as prevalent for soybeans as they were for the rapeseed futures market.

The price determination process for rapeseed futures contracts appear to be influenced by factors in both domestic and export markets, with one of the more influential effects being that of American soybeans. Soybean price determination also occurs in the open market, based on futures prices established in the major American futures markets, the Chicago Board of Trade and the Kansas City Board of Trade.[3]

Soybeans are the world's largest oilseed crop, accounting for 50 percent of all oilseed production. The United States is the largest oilseed producer, and soybeans are the largest component of the American oilseed industry. The United States has a huge crushing industry and is a residual supplier of oilseed products to world markets (Donkers, 1987). Due to the proximity of the two futures markets and the substitutability of soy and canola products, important links appear to exist between the two market prices for canola and soybeans (Carter and Rausser, 1983; Donkers, 1987; Veeman and Moreau, 1985). In view of the relatively high oil content of canola relative to soybeans, the relationship between futures prices for soy oil and Canadian canola prices are of particular interest. However, analytical studies quantifying this link are lacking.

This thesis will reinforce existing studies of the Canadian canola market by providing an empirical analysis assessing the relative importance of the rapeseed futures prices established on the Winnipeg Commodity Exchange and the futures prices for soybeans and products established on the Chicago Board of Trade in the process of canola cash price determination. Possible influences of specific aspects of the world oilseed market on the

[3] The Chicago Board of Trade is the largest American futures market that trades the soybean complex.

reported results will also be discussed.

Economic analysis of the price mechanism for canola is warranted by the importance of canola production and processing to the Canadian and prairie economies. An understanding of the pricing mechanism in order to improve decisions regarding marketing alternatives may be particularly important in periods, as in the mid to late 1980's, when producers and processors face increasing input costs and depressed markets. It is hoped that this study will provide information regarding canola price determination which could be of use to producers, processors and legislators.

C. Objectives

The specific objectives of this study are to:

1. Assess the strength and direction of lead-lag relationships between daily rapeseed futures prices, soybean, soyoil and soymeal futures prices, and cash prices for canola in the period from 1983 to 1986; and
2. Examine changes in both foreign and domestic oilseeds markets between 1983 and 1986 that may have influenced the lead-lag relationships between rapeseed futures prices, soybean, soyoil and soymeal futures prices, and canola cash prices.

D. Hypotheses

The analysis contained in this thesis was directed toward four hypotheses. These are:

1. Prices for rapeseed futures contracts established at the Winnipeg Commodity Exchange (W.C.E.) rapeseed futures tend to lead street prices for canola applied by the Alberta Wheat Pool (A.W.P.) during the period studied.
2. In view of increasing maturity and liquidity in the W.C.E. rapeseed futures contracts it is hypothesized that the time lag between the establishment of rapeseed futures prices and A.W.P. cash prices will tend to diminish over the period from 1983 to 1986.
3. Prices for soybean, and product futures contracts established on the Chicago Board of Trade (C.B.O.T.) tend to lead street prices for canola applied by the A.W.P. over the

time period studied.

4. Due to the relatively high oil content in canola (40 percent) compared to that in soybeans (20 percent) it is hypothesized that there is a stronger lead-lag relationship between U.S. soyoil futures prices and Canadian canola street prices than between U.S. soybeans or soymeal, and canola street prices.

E. Methodology

The assessment of the relative importance of futures prices established in rapeseed, soybeans, soyoil and soymeal markets in the process of canola cash price discovery is performed using the Geweke technique of lead-lag analysis to identify Granger causal structure. Geweke models use ordinary least squares regression techniques to test for temporal structure between variables. Statistical properties of the parameters are examined in order to ensure the validity of the results. The results are then used to formulate conclusions about the lead-lag structure between variables. Factors thought to have influenced the results are discussed during the analysis. Theoretical or methodological weaknesses inherent in the testing procedures used in the analysis are discussed.

F. Outline

This thesis is composed of six chapters. Chapter two provides a brief overview of the oilseed industry and includes a discussion of the role of futures contracts in canola marketing. Chapter three presents the theory, methodology, and data used in assessing the lead-lag relationships between canola street prices, rapeseed futures contracts, and soybean and products futures prices. This chapter also includes a summary of the data transformations used in the analysis. Chapter four presents the estimated model parameters and tests of significance. Analysis of the results from the lead-lag tests are included in Chapter five. The final chapter contains a summary of the results, states the conclusions and gives recommendations for further areas of research.

II. Background

A. History

The term rapeseed is derived from the latin word **capum**, meaning turnip. Other genetic family members include common vegetables such as rutabagas, cabbages and brussel sprouts. Originally, the utilization of rapeseed oil was based on its characteristic properties of smokeless burning and the ability to cling to steam washed surfaces, which made it a very good lubricant. It was the second quality which acted as the impetus for the production of rapeseed in Canada.

The initial stimulus for commercial production of rapeseed in Canada occured in 1943 when oils and fats administrators requested that it be specified as a war emergency crop.[4] The request came as a result of a combination of factors, including the wartime blockade of European and Asian sources of the crop and the extensive use of rapeseed oil as an engine lubricant for naval and merchant ships. The oils and fats administrators' request was granted and the Canadian Wheat Board began to promote the crop by offering a guaranteed price of three dollars per bushel of production.[5] Control remained in the hands of the Wheat Board until 1949, when it relinquished marketing power and withdrew the guaranteed price. During this six year period there was a large increase in Canadian rapeseed acreage--3200 acres were produced in 1943 and by 1949 there were 80,000 acres of rapeseed. Production was distributed mainly between the two provinces of Manitoba and Saskatchewan (Boulter, 1983).

Wartime shortages also reduced the amount of off-shore edible oils and fats available in Canada. For this reason small quantities of rapeseed oil began to be used for human consumption. Since the original seed stocks were not uniform in quality the refining process was difficult. Rigorous bleaching was required of the oil used for human consumption, and

---

[4] A Saskatchewan farmer had produced a small amount of Polish rapeseed for a few years around 1936, but the lack of an established marketplace had impeded continued production of the crop (Perkins, 1976).

[5] Motivations for producers to gamble on this relatively untried or untested crop included the existence of large wheat stocks which resulted in a wheat acreage reduction plan, and a market price for wheat of around 75?/bu. (Perkins, 1976).

good deoderization was difficult.

Fixed rapeseed prices and off-shore shortages of alternate oilseeds resulted in a large increase in the production and crushing of Canadian rapeseed. However, at the end of the war, availability of traditional oils resulted in the removal of the guaranteed price and by early 1949 the Canadian Wheat Board had relinquished market control of the crop (Perkins, 1976). Although outlets were found for the 1949 rapeseed crop, the availability of alternate supplies of industrial grade oil resulted in very low returns for Canadian producers. By 1950 the crop had almost disappeared. Despite this dismal outlook a relatively small, but determined, group of scientists at the Prairie Regional Laboratory continued to advocate that the crop was well adapted to the Canadian prairies and that domestic rapeseed production had the potential to replace a large quantity of imported vegetable oils. The Canadian crushing industry also played an important role in developing a market infrastructure for rapeseed. J. Gordon Ross of Moose Jaw, Saskatchewan, who had built and operated the Prairie Vegetable Oil Ltd. crushing facility, continued to contract production and search out rapeseed oil markets. Mr. Ross and other members of the crushing industry bore a large share of the cost burden, both financially and by providing expertise, manpower, equipment, and quality evaluation (Boulter, 1983).

Support and teamwork between scientists from both government and universities, and the members of the processing industry, are considered to be key factors in the development of the low glucosinolate, low erucic varieties of rapeseed which are today so vital to the Western Canadian agricultural system (Boulter,1983). This was particularly evident during the late 1960s and early 1970s. On July 23, 1956, the Food and Drug Directorate of the Department of National Health and Welfare ruled that rapeseed oil was not qualified to be used for human consumption in Canada, and that production of the oil for human consumption was to cease immediately, since high levels of erucic acid were associated with heart problems in laboratory rats. In October of the same year, test results revealed during a meeting of the Canadian Committee on Oils and Fats demonstrated that human consumption at present levels did not constitute a hazard to the Canadian population. Although the ban on

rapeseed oil was lifted, it was decided that further research into the erucic acid problem was required. Research continued and by the mid 1960's low erucic acid varieties became available for sale.

The higher costs associated with the low erucic acid rapeseed (LEAR), combined with the availability of other supplies of oils resulted in the dampening of interest in LEAR varieties in the late 1960s. By the early 1970s the questions concerning the health problems associated with erucic acid levels in oils had returned. At this time the production of the LEAR varieties had become somewhat more developed with progress made by plant breeders limiting the erucic acid level to under 5 percent. In 1973 the Canadian rapeseed industry voluntarily established guidelines to limit the level of erucic acid in edible rape products to under 5 percent. At the present time rapeseed oil has a erucic acid content of less than 2 percent (Boulter, 1983).

Concerns with the level of glucosinolates in rapeseed meal also caused problems for the industry. Rapeseed contained high levels of thioglucosides which reacted to available enzymes during the crushing process and produced glucosinolates. Animals exposed to specific levels of glucosinolates were found to have problems with goiter. This problem was of concern to the rapeseed industry since rapeseed meal, a by-product in the production of rapeseed oil, is used as a high protein meal for livestock. Once again, there was a successful search for improved cultivars of rapeseed. The characteristics of these new varieties included not only a reduction in the level of glucosinolates, but also an increase in the levels of certain essential fatty acids such as oleic, and linoleic acids. Further research and experimentation continued to result in improvements in the oilseed and the acceptance of the product by both producers and consumers. Rapeseed's ability to provide a viable alternative crop for Canadian cereal producers was demonstrated in the late 1960s and early 1970s during a period of low prices for more established prairie crops.

Canola is a more management sensitive crop than other more traditional cereals and one major difficulty is that this crop is not very drought or heat resistant. Added efforts to improve management by producers are, nonetheless, highly rewarded in terms of

productivity.[6]

Characteristics of Rapeseed/Canola Oil

The increasing production and utilization of canola was highly related to the development of "double-low" varieties. These cultivars produce rapeseed oil obtained from whole seeds that contain 5 percent or less erucic acid and the meal obtained from the oilseed crush contains less than thirty micromoles of glucosinolates per gram of meal (Lennox, 1984; Boulter, 1983). In 1980 these double-low varieties of oilseeds from the species Brassica Napus or Brasica Compestris were given the name canola.

Canola oil has very good cooking characteristics with excellent cold storage stability and good frying properties since it resists clouding and has a high smoke point. The oil does have a tendency to grain during hydrogenation and must be blended with other vegetable oils when used in margarine manufacture in order to maintain the desired consistency (Carr, 1986).

Characteristics of Rapeseed/Canola Meal

Canola meal contains 36 to 37 percent protein, and is a good supplement in livestock feeding having higher calcium and phosphorus levels and higher levels of the amino acid methionine than are found in soybean meal (Boulter, 1983). Although the majority of rapeseed markets prefer a product with low levels of erucic acid, there is a small outlet for rapeseed with high levels of erucic acid and low levels of glucosinolate, due to its excellent lubricating properties. The variety is called R-500 and is grown under contract for industrial use. Very little R-500 is grown in Canada. Ninety percent of all rapeseed grown in Canada today is of the double-low variety.

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[6] Canola requires intensive management practices, especially in seedbed preparation and fertilizer and chemical application methods. It responds well to fertilizer application, particularly in the presence of adequate moisture. In aggregate the net revenue from an acre of a well managed canola crop compares favorably with other cereals (McClintock, 1986).

B. Marketing Associations

Economic development of rapeseed was aided by the Canadian crushing industry. As the industry became established, marketing associations allocated funds to help develop infrastructure, explore markets, and contribute to research and development to obtain an improved product (Perkins, 1976). In 1967 the Rapeseed Council of Canada was formed to represent interests of producers, processors, and exporters. The name of this organization was subsequently changed to the Rapeseed Association of Canada. This association played an integral part in the subsequent recognition of rapeseed/canola as a viable and important component of the western Canadian oilseed industry. It was replaced by the Canola Council of Canada in July 1980. As was the case with the original association, the Council is not involved in buying or selling of the products, but is concerned with market development and coordination of activities related to the canola industry.

C. State of the Industry

The Oilseed Industry

Cooperation between sectors of the Canadian canola industry and the evolution of Canada as a world leader of canola research and plant breeding have resulted in a high level of success in canola product development over the past thirty years (Boulter, 1986). The degree of acceptance of canola by Canadian consumers is illustrated by the fact that on the average, Canadians consume 20 grams of canola oil per day (Vaisey-Genser, 1986). Despite the high level of domestic usage, the Canadian canola industry is still largely an export based industry. Forty-five percent Canadian canola seed is exported, primarily to Japan, while 50 percent of canola products are exported to the U.S. and off-shore markets (Broeska, 1986). The world market for oilseeds thus has a large impact on the Canadian canola industry.

Vegetable oils and protein meals are derived from the crushing of oilseeds. Oilseed crushing expels the oil first and further processing is required for meal production. Since oil and meal production are not independent, there may be an expanding supply of meal

regardless of the price of meal if oil prices are relatively high. The chief components of utilization for oil are in food and soap industries, while demand for meal is a function of the animal food market.

Real levels of many commodity prices have been fluctuating around a declining trend since 1980 (I.M.F., 1987). The International Monetary Fund (I.M.F.) postulated that this price fall was at least partly attributable to sluggish growth rates in industrial countries which account for two-thirds of world commodity imports. Despite this, real price indexes for vegetable oils and protein meal rose 26 percent between 1982 and 1984, declined by 25 percent in 1985, and showed a further decline of 15 percent in 1986 to the lowest level since 1972 (I.M.F., 1987). World production of oilseeds increased every year during the 1980's, with the exception of the 1983/84 crop year. This growth in oilseed production can be attributed to the expanded production of three main oilseeds. Palm oil accounted for 23 percent of the growth, while soybean and canola producted for a growth of 21 percent and 18 percent respectively (I.M.F.,1987).

Major developments in the soybean and palm oil markets over the past 16 years have affected the Canadian canola ifidustry due to the high level of substitutability of this oil. Since 1970, Brazilian soybean production has increased 685 percent to 16.3 million tonnes; Argentina's production increased by 15 times to 7.1 million tonnes; United States soybean production increased 78 percent, to 55 million tonnes. Malaysia's production of palm oil has increased from 600 thousand to 4.5 million tonnes, or by 657 percent, between 1970 and 1986(Donkers, 1987). Soybean production is still the most important component of the world oilseed industry, accounting for approximately 50 percent of all oilseed production in 1986 (Donkers, 1987).

Another important development for the Canadian oilseed industry occurred in 1973, when the European Economic Community (E.E.C.) introduced a policy designed to encourage oilseed production within the community. E.E.C. rapeseed production has risen to 5.3 million tonnes in 1987 (Toepfer, 1987) and this region is now the second largest rapeseed producer in the world, behind China.

The E.E.C. is also beginning to produce varieties of rapeseed containing low levels of both erucic acid and glucosinolates. German farmers have completely adopted canola production, and France is also expected to increase canola acreage (Toepfer, 1987). Canola production in the E.E.C. is promoted by a premium for low-glucosinolate rapeseed. By 1991/92 the rapeseed processing subsidy will only be paid on double zero varieties (Toepfer, 1987).

D. Canola Crushing

The increasing trend in world oilseed production over the past two decades has affected Canada's canola markets. The increases in world vegetable oil production over the past sixteen years is a result of large increases in Malaysian and Indonesian palm oil production, combined with increases in production of canola in Canada and rapeseed in the E.E.C. A large proportion of the increased world vegetable oil production enters export markets adding to competitive pressure for these products. [7]

In an attempt to increase value added, developed countries constructed many vegetable oil crushing and processing facilities during the 1960's and 1970's. American farm price support programs resulted in higher prices for oilseed products in world markets, leading to increased oilseed production and investment in processing facilities in countries like Brazil and Canada (Donkers, 1987). Government incentives in such countries appear to have contributed to excess crushing capacity. Brazil currently has crushing capacity for almost double the Brazilian soybean production. Canada has a crushing capacity of 1.6 million tonnes, only 80 percent of which is typically used. Over capacity in the oilseed crushing industry has resulted in serious economic problems. In turn, these problems have caused further changes within the industry. Several U.S. plants have been closed, while the ownership of others has been consolidated (Donkers, 1987).

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[7] Increased demand for soymeal products, the production process of which also produces soyoil as a by-product, has also contributed to the increasing production of vegetable oils.

The Canadian canola crushing industry is comprised of seven companies which operate nine plants. Four of these are in Alberta. One is located in Saskatchewan, two are in Manitoba and two in Ontario. Crushing produces a semi processed product which is further refined into salad oil, margarine, or other foods. In 1985 total value added from Canadian oilseed crushing and milling, of which canola is the largest component, was approximately 118 million dollars (Statistics Canada, 1987c). Canada's crushing industry is unusual in that only 38 percent of total canola production, (representing 7 percent of world rapeseed crush) was crushed domestically in 1986. Most other producing countries crush virtually all of their production.[1] Rapidly expanding western Canadian canola production, good prospects in oilseed markets, and a strong domestic market combined with government support to promote the expansion of crushing industry over the past 12 years. Since 1975 the Canadian crushing capacity has increased by approximately three hundred percent (Donkers, 1987). In 1986 Canadian processors achieved a record crush level of 1,304 thousand metric tonnes (Adolphe, 1987). Canada's situation is complicated by the large exports of EEC canola oil, Malaysian palm oil and the sale at low prices of soyoil surpluses by Brazil and Argentina. These factors have combined to create a very competitive market for vegetable oil in which it is difficult to compete profitably.

Canola Oil

Canola crushing yields over 40 percent oil. Thus the world price of vegetable oil is an important influence on canola prices. Canada is a very small player in the world vegetable oil market with exports of approximately 230,000 tonnes of oil per year (Adolphe, 1987). Almost eighty percent of these exports were to India, the U.S.A. and Hong Kong. The Canadian International Development Agency (C.I.D.A.) is also an important buyer of canola oil, purchasing in excess of sixty-six thousand tonnes of the product in 1986.

The largest gains in canola oil acceptance have been made domestically. Canadians are the largest per capita consumers of canola oil in the world (Boulter, 1986). In 1986, the

[1] Japan, which has no canola production, crushes more Canadian canola than Canada does.

production of deoderized margarine, salad, cooking and shortening oils, consumed 311,000 tonnes of canola oil, which represents 58.3 percent of total vegetable oil consumption in Canada (Adolphe, 1987). The major use of canola oil is in the production of salad oil, where it captured 78.9 percent of the market in 1986, compared to 77.4 percent in 1985. Canola oil usage, as a percent of total oil used in margarine production, remained steady at 38.2 percent over the two year period, while demand for canola oil increased 3 percent to 49.4 percent of total oil used in shortening oil production (Adolphe, 1987; Boulter, 1986).

Canola Meal

Due to the high oil content of canola seed, the value of this commodity is closely tied to the world vegetable oil market. The value of the meal produced as a by-product of canola crushing is determined by the economics of the protein feed market. 1986 Canadian canola meal production was 691 thousand tonnes. Domestic disappearance was close to 400 thousand tonnes, a large increase from the 165 thousand tonnes consumed in Canada during 1976/77. This 142 percent increase in meal useage over a ten year period represents a large increase in the market share of canola meal in animal feed supplements (Donkers, 1987).

Export demand for canola has been rising as has the increase in domestic demand. In 1986 canola meal exports were slightly over 300 thousand tonnes, with the United States being the largest single importer with 121 thousand tonnes. The Pacific Rim countries accounted for 55 percent, or 180 thousand tonnes of 1986 demand (Adolphe, 1987).[9] It appears that an important factor in the growth of export demand for Canadian canola meal has been the development of high quality canola varieties (Boulter, 1986).

Other factors affecting recent increases in American imports of Canadian oil meal include transportation rate subsidies. In 1984, Bill C-155 came into effect subsidizing the rail transport of canola products to export shipping points. Exchange rate influences may also have affected American demand for canola meal. Canadian exports of canola meal may have benefitted from the fall in value of Canada's dollar which made Canadian canola meal exports

[9] The Pacific Rim countries accounting for canola meal imports included Japan, Indonesia, Korea, and Taiwan.

to the U.S. cheaper relative to American soymeal.

E. The Role of the Futures Market

Trading in rapeseed futures contracts on the Winnipeg Commodity Exchange began in September of 1963. The commodity exchange is an organized public marketplace in that anyone who makes the necessary arrangements with member brokerage firms can be involved in trading.

A futures market is a mechanism which allows for the trading with deferred delivery in standardized contracts of various commodities. The main function of a futures market is to facilitate the hedging of transactions during periods of volatility of market prices. In some respects a futures contract is similar to a forward contract, however, the two are different entities.[10] Scholes (1985) stressed three important functions served by a futures market:

1. Standardization of contracts makes the futures market a more efficient alternative than forward contracting or other means of hedging or speculating;
2. The futures market allows for the reduction of risk associated with those activities that serve to carry a commodity forward; and
3. Futures prices can give more appropriate and efficient signals of commodity prices than those given in other diverse markets.

Standardization of Contracts

The futures contract is a commitment to purchase or sell an underlying asset at some specified time in the future. By combining an appropriate futures market transaction concurrently with a cash market transaction the participant is able to provide himself with a hedging mechanism to minimize the possibility of a loss. Contracts are standardized in that

[10] The value of a futures contract is negotiated daily with market participants having to maintain minimum margin requirements, while the value of a forward contract is settled only at the maturity of the obligation. With the futures market the clearing house acts as an intermediary and guarantees performance, but is not responsible for risk. Defaults are left in the hands of exchange members (Longman Financial Institute Inc., 1986).

they apply to a given delivery month and the margin rules are specified. In this way, both buyer and seller are assured of certain temporal, quantity and quality considerations.

Hedging for Risk Reduction

Proper hedging shifts the risk of absolute price changes, and therefore alters the nature of market risk from a price level risk to a price relationship risk. It is widely believed that the risk of a change in the price relationship or basis behavior, is considerably smaller than the risk of an absolute price change (Thiessen, 1970; Scholes, 1985; Fort, 1986; Adler and Detemple, 1986). Although hedging can lower the risks associated with market price change, it must be done carefully. Routine hedging may prevent losses from adverse price changes, but it may also limit the gains from beneficial market price changes. Hedgers must be aware of the current price trends in order to fully benefit from initiating a hedge. A canola producer who hedges his crop only benefits from the hedge if the market price of canola drops below the price level set by the hedger. If canola prices rise, the hedger foregoes the benefits of the rising price.

Two basic types of hedgers may function in any futures market, the long hedger and the short hedger. The long hedger purchases futures contracts to offset forward cash sales. One of the more obvious uses of a long hedge would be made by exporters who make forward cash sales of canola into export markets, and then cover this forward sale with the purchase of a similar volume of rapeseed futures contracts.

A short hedger is one who bought or holds the cash commodity and sells the futures contract to activate the hedge. Elevator operators are obvious examples of the short hedger. When the elevator operator purchases canola from the producer, the immediate sale of the same amount of rapeseed on the futures market will hedge against a loss should the cash price of canola fall prior to the sale of the commodity.

Futures Markets and the Price Discovery Process

Hedgers and speculators have a very important role in the price discovery process of canola. A major purpose of any market is to discover equilibrium prices, that is, the set of prices at which the market will be cleared. Prices may tend to fluctuate about an equilibrium value. Speculators who trade without owning or holding the commodity may have an important role in price determination by adding to the volume of transactions and acting as arbitragers should price relations appear to be out of line either in space or time (Thiessen, 1970).

Essentially, the price for canola is established by world oilseed demand and supply factors. Anticipated future prices are represented by the futures price for rapeseed contracts established on the Winnipeg Commodity Exchange. This information is then interpreted by the prairie elevators in deriving street prices in each region of production.[11] Market participants must integrate this street price into their decision making process.[12] The provision of information concerning the linkage between futures and farm prices is thus of much importance to all segments of the industry.

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[11] For discussions of basis behavior and other intertemporal price relations, see: Gold, 1975; Hieronymus, 1971; Thiessen, 1970; Telser, 1958; and Working, 1948.

[12] Restrictive delivery quotas for canola may not allow price arbitrage to occur freely between the two markets which could disrupt the synchronization of price movement between futures and spot markets. However, delivery quota restrictions have not been a serious problem for canola market participants over the time period studied.

III. Methodology Relating to Causality Tests

A. Introduction

The detection, verification and quantification of meaningful relationships between two time series has long been an area of concern for economists. Wiener (1956) was the first to establish a formal definition of causality between two time series which could be used to analyze the linkages between them (Hipel, Li, and Mcleod, 1981). The current concept of a particular form of causality theory resulted from the work of Granger (1963, 1969), who modified Wiener's work and introduced the theory to economists (Geweke, 1984). Since the time of Granger's study, many researchers have adapted Granger's (1969) definition to fit their own analysis of causal relationships (Bessler and Brandt, 1982; Blank, 1985; Geweke 1984; Haugh, 1972, 1976; Mcleod, 1979).[13]

Although Granger's (1969) definition of causality is very useful in the construction, estimation and application of econometric models, it does have serious limitations. Many statisticians and philosophers of science feel that Granger is careless in the specification of the definition of causality. Specifically, statisticians feel that the proofs used in equating causality with correlation are weaker concepts than those required by an appropriate statistical proof (Conway *et al.*, 1984). In order to satisfy the concerns related above, most researchers now tend to use phrases like causal ordering, or time ordered association to refer to Wiener-Granger causality. Despite its shortcomings or inconsistencies, few would argue the usefulness of the Wiener-Granger definition of causality in the conceptualization, construction and estimation of temporal relationships between two time series (Geweke, 1984).

[13] Pierce and Haugh (1977) provide a comprehensive survey regarding research on causal structure and lead-lag relationships.

The Theory of Wiener-Granger Causality

Granger (1969) was the first to formalize a technique to determine and observe price interdependency using cross correlation causality methods and for this reason the process has become known as Granger causality. The technique involves inducing stationarity into the two time series to be analyzed by differencing or using log transformations on the data series.[14] The stationary series is then diagnostically analyzed for any evidence of autocorrelation.[15] After reducing the two time series into their white noise components, the series are cross correlated to test for causal, that is, temporal relationships.

The form of causality analysed here refers strictly to statistical relationships between data series rather than to behavioral relationships. The approach allows for the generation of testable hypotheses concerning the existence, direction and strength of interrelationships within independent time series. Although this discussion concentrates on the comparison of two series, the analysis can be expanded by investigating all combinations of the relevant series.

The major patterns of temporal ordering can be discussed with reference to two stationary white noise series of data, x and y. Series x is said to cause y if one is better able to predict y by using all available information, including x, than by incorporating all available information excluding x. Instantaneous causality is said to exist if the current value of y can be significantly more accurately predicted when the current value of x is used than when it is not. Feedback is said to exist when x both causes y and is caused by y. The notation for the various possible test results can be represented as:

1. x causes, that is, leads y : $x \rightarrow y$
2. y causes, that is, leads x : $y \rightarrow x$

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[14] A stationary process is one which has a constant and finite mean and variance, and has the property that the covariance between two members depends only on their distance in time (Harvey, 1981).

[15] The absence of an autoregressive structure in the data series is of great importance to the interpretation of causal structure. If autocorrelation exists within a series, confusion arises as to the extent of the explanatory power of variables within the time series analysed, as it is impossible to determine if it is the variables or the auto regressive structure which is generating a causal relationship.

3. instantaneous causality : $x \leftrightarrow y$
4. feedback, that is, x both leads and lags y, : $x \rightarrow y$, $y \rightarrow x$
5. x and y are independent : $x \cdot y$

Granger's method restricts the definition of causality in order to reach a testable hypothesis. A hypothesis concerning the lead-lag relationship between two white noise time series is formulated. The hypothesis is tested and the tests are interpreted. It is important to note that the interpretation of the results may be biased if the data series are not properly selected. If $x \rightarrow y$ by one period, but the data are selected at two period intervals, one may inappropriately conclude that there is instantaneous causality. Thus it is important to pick frequent time intervals in data selection in order to reduce the risk of bias. Apparent instantaneous causality may also result from the incorrect specification of causal variables. It is also important to note that difficulty occurs when trying to infer any type of causality from a purely deterministic series; for this reason non-stochastic series are not usually tested.

There are a large number of time series studies designed to observe temporal orderings and generate inferences concerning Granger causality. See for example, Adamowicz (1984) Adamowicz, Baah and Hawkins (1984) Bessler and Schrader (1980) Garcia, Leuthold and Zapata (1986) Geweke (1984) Geweke, Messe and Dent (1983) and Sims (1972). Benson and Faminow (1987) credit the frequent use of Granger's theory to five main advantages associated with it. First, the process is based upon tests of statistical hypotheses so that personal judgement of the researcher is limited. Second, the method is data efficient in that reasonable tests of interdependence can be made given available data. Third, since present and past data are utilized together, adjustment processes may be evaluated. Fourth, the process permits the analyst to observe interdependence between series. Fifth, the analysis is generally accepted within the economics profession. Nonetheless, the limitations of the procedure must be understood. Studies should select appropriate variables, to be tested on the basis of appropriate economic theory and a priori evidence. Causality test results must be recognized as statistical rather than behavioral evidence. Despite the limitations of Grainger's procedure such as the inability to analyse more than two variables at one time, the dynamic nature of

the time series approach combined with these other advantages makes it more attractive for this study than structural models which are static in nature and difficult to develop and interpret.

Agricultural economists have long been concerned with the problems concerning the explanation of price adjustments and relationships within specific commodity groupings. Methods developed to examine the temporal ordering or lead-lag relationship between two time series have been empirical in nature as these allow the data to specify any existing dynamic relationship (Bessler and Brandt, 1982). Theory utilized in the formation of the complex structural models (for example, the FARM model from Agriculture Canada) is often ambiguous as to the direction and strength of the lead-lag relationship between variables. In some instances, the existing theory may not clearly indicate the important variables. Empirical methods may then be of assistance to the substantiation of theory. A properly applied empirical method may allow the raw data to suggest the existence and extent of relationships within the agricultural sector.

Testing for Causal Structure

Geweke, Meese and Dent (1983) discuss eight alternative tests of causality in temporal systems in an attempt to compare alternative tests of the same hypothesis. Geweke *et al* investigate the properties of various tests of the hypothesis that y does not cause x. The eight tests include three variations of Granger's estimation procedure, two versions of Sims' estimation of causal relationships using a feasible generalized least squares estimator (F.G.L.S.), and three variations of Sim's test which avoids the need to use a F.G.L.S.

Geweke *et al* represent the question of whether y leads x as a two equation system:

$$x_t = d(L)x_t + e(L)y_t + z_t, \text{ and} \qquad (3.0a)$$

$$y_t = a(L)x_t + b(L)y_t + q_t \qquad (3.0b)$$

in which d(L) is a polynomial in the lag operator of the dependent variable (x_t); and e(L) is a polynomial in the lag operator of the independent variable (y_t). In 3.0b, a(L) is

a polynomial in the lag operator of the independent variable (x_t); b(L) is a polynomial in the lag operator of the dependent variable (y_t); and z_t and q_t are the error terms of these two equations. This two equation system is commonly represented in matrix form. Grainger's method consists of estimating (3.0a) by ordinary least squares and testing the hypothesis that e(L) = 0 in the conventional way (Geweke *et al*, 1983).

Sims (1972) considers both the regression of y_t on current and past x_t, and the regression of y_t on future, current and past x_t, when observing the implications of the condition e(L) = 0 (Geweke *et al*, 1983). The first of these two regressions expresses y_t as a function of past and present while the second regression expresses y_t as a function of future, past and present x_t.[16] The Sims test evaluates the hypothesis that y_t does not cause x_t. According to this test, this is the case if and only if the second regression indicates only current and past x_t as significant influences. If future values of x_t are a significant component of the function estimating current values of y_t, the hypothesis that y_t does not have a causal effect on x_t cannot be accepted. The Sims equations must be estimated using feasible generalized least squares due to serial correlation between the error terms of the two Sims regressions (Sims, 1972). There is a variant of the Sims test in which an ad hoc prefilter is used to deal with the serial correlation problem. This prefilter allows the use of methods other than generalized least squares estimators (Geweke *et al*, 1983). Both versions of the Sims test are analysed in the Geweke, Meese and Dent (1983) article.

Geweke *et al* test each of the three approaches noted above, and evaluate the linear restrictions of each null hypothesis of lead-lag behaviour using Wald, likelihood ratio, and LaGrange-multiplier tests. This comprehensive review suggests that the Wald variant of the Granger or Sims lagged dependent variable tests are the two most robust methods of testing for causal ordering.[17] Three main advantages of the Wald variant of the Geweke or Sims approaches are cited as:

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[16] A detailed description of the expressions used in the Sims calculations is given in the article by Geweke *et al* (1983).

[17] The modified version of Granger's approach will be referred to as the Geweke approach for the remainder of this report.

1. In the comparison of the Wald, likelihood ratio, and LaGrange-multiplier tests of the same hypothesis, the Wald variant of the Geweke and Sims tests are found to be adequate in their ability to reject the null hypothesis under various alternatives.
2. The sampling distribution of the Wald variant of the Geweke and Sims tests under the null hypothesis are satisfactory, and the alternative rejection frequencies corresponded very closely to those indicated by asymptotic theory.
3. The Wald variant of the Geweke lagged dependent variable tests are easy and inexpensive to compute.[18] However, the variants of the Sims test requiring corrections for serial correlation by using generalized least squares estimators are more difficult to compute due to decisions concerning parameterizations (Geweke *et al*, 1983; Adamowicz *et al*, 1984).

In their analysis of causal relationships between weekly hog prices for Edmonton, Toronto and an average of mid-west American markets Adamowicz, Baah and Hawkins (1984) use both the Geweke approach and an ARIMA filter process.[19] They conclude that both methods provide comparable results but that the ARIMA models suffer considerably from a subjective identification procedure and various other econometric problems.[20]

Although Wald variants of the Geweke and Sims lagged dependent variable testing procedures are considered to perform at the same level, the Geweke version appears to be easier to compute and analyse due to the serial correlation problems with the Sims test. The Wald variant of the Geweke approach is a convenient method of testing the restrictions in both linear and non-linear regression models. However for a linear model with a large sample size the Wald statistic converges to an F-statistic (Harvey, 1981; Cramer, 1946). For this reason hypothesis testing of Geweke results are conducted using

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[18] Results of Geweke tests are based on the assumption that the series are generated by a stationary stochastic process with a constant variance, or could be reduced to this type of series through the use of a pre-whitening process.
[19] ARIMA models provide a filter for the autocorrelated structure of a time series when properly fitted to the time series.
[20] Sims (1977) criticized the use of ARIMA models for the evaluation of causal relationships because of the biased U-test used to test for the significance of one way causality.

F-statistics.

It is important to stress that empirical analysis, using lead-lag procedures such as the Geweke test, should only be used as a means of testing relationships indicated by theoretical concepts or a priori evidence. In this analysis causality refers only to an observable statistical ordering. Theory and observed behaviour should be used as a guide in the choice of variables tested and in the determination of the lag length (Sims, 1977; Granger, 1969).

B. The Geweke Approach

Of all the various procedures used in applying Wiener-Granger theory to time series analysis, the Geweke approach is considered to be one of the most efficient. The Geweke approach is frequently used in the literature (Adamowicz, Baah and Hawkins, 1984; Bessler and Brandt, 1982; Garcia, Leuthold and Zapata, 1986; Geweke, 1984)..

The notation used here in testing the Geweke model for undirectional causality (UC) from x to y (i.e., $x \rightarrow y$) follows Garcia, Leuthold and Zapata (1986). The model is represented by:

$$M_0 = y_t = \alpha_0 + \sum_{i=1}^{k} \beta_i y_{t-i} + e_{0t} \qquad (3.1)$$

and

$$M_1 = y_t = \alpha_1 + \sum_{i=1}^{k} \beta_i y_{t-i} + \sum_{j=1}^{m} \gamma_j x_{t-j} + e_{1t} \qquad (3.2)$$

where: y represents the dependent variable ;

x represents the independent variable;

M_0 is the expression for an equation which is composed of lagged values of the dependent variable ; and

M_1 is the expression for an equation which is composed of lagged values of both the dependent and independent variables.

The two error terms e_0 and e_1 are assumed to be white noise residuals. In testing for

undirectional causality from x → y the significance of including the variable x in equation 3.2 as compared to equation (3.1) is investigated. Empirically speaking, testing for the undirectional causality from x → y is equivalent to testing the null hypothesis that $\gamma_j = 0$ for $j = 1,2,\ldots,m$. The null hypothesis is tested using the following F statistic,

$$F_e = \frac{(RSS_0 - RSS_1)/m}{RSS_1/(T-k-m-1)}, \tag{3.3}$$

where RSS_0 and RSS_1 are the residual sum of squares from Eequations 3.1 and 3.2, respectively. The number of observations on variable y is represented by T and k is the number of lags for the dependent variable while m is the number of lags for the independent variable. The null hypothesis is that past values of x have no effect on y, and under this hypothesis F_e is distributed as F with (k, T-k-m-1) degrees of freedom. If $F_e > F$, at a desired level of significance, then the null hypothesis is rejected.

Following the first step outlined above, a similar process is applied to test the hypothesis that y does not lead x. Substituting x for y, and y for x in equations 3.1 and 3.2 gives the appropriate models. Again, F_e is calculated using Equation 3.3 and is compared to the F distribution with (k, T-k-m-1) degrees of freedom. The null hypothesis, that y does not lead x, is rejected at a desired level of significant if $F_e > F$. If neither null hypothesis is rejected then it appears that x does not lead y, and y does not lead x. This would suggest that there is no lead-lag relationship between the variables and they are considered to be statistically independent. Rejection of one null hypothesis suggests that unidirectional causality exists, implying either x leading y or y leading x. Rejection of both null hypotheses suggests that x leads y, and y leads x. This occurance is termed feedback, and the lead-lag relationship between the two variables is difficult to interpret.

Up to this point the tests outlined have been to check for the existence of a temporal relationship between a dependent variable and a lagged independent variable. Existence of a temporal relationship suggests that the lagged independent variable influences the present

value of the dependent variable, or that there is some form of a lead-lag relationship between the two series. Testing for a contemporaneous or instantaneous relationship requires changes in the restricted and unrestricted equations in the lead-lag test. A test for no instantaneous correlation includes considering equation 3.2 to be the restricted equation, and comparing it to equation 3.4 below,

$$M_2 : y_t = \alpha_2 + \sum_{i=1}^{k} \beta_i y_{t-i} + \sum_{j=0}^{m} \gamma_j x_{t-j} + e_{2t}, \tag{3.4}$$

where j = 0,1,2,...,m. This tests the null hypothesis, i.e. that Ho : $\gamma o = 0$. Tests of this hypothesis are performed in the same manner as tests of the hypothesis $\gamma_j = 0$, for j = 1,2,...m, with application of the F test distributed with (1, T-k-m-2) degrees of freedom.

If autocorrelation is present in the models, this factor is important in affecting the validity of the tests. A Ljung-Box Q test is used to test each equation for the presence of significant autocorrelation. The test statistic takes the form:

$$Q(\hat{r}) = T(T+2) \sum_{k=1}^{b} (T-k)^{-1} \hat{r}^2_k \tag{3.5}$$

where b=50, $\hat{r}_k$ represents the residual autocorrelations and $Q(\hat{r})$ is asymptotically distributed approximately χ^2 (b).[21]

Data

The data used in applying the model outlined above were collected from three separate price series. Daily price data were used for each of the three series for the time period from January 4, 1982 to December 31, 1986. Farm level prices were represented by the Alberta Wheat Pool's series of daily closing street prices for canola. Daily futures price data for the five rapeseed futures contracts covering four contract years from 1983 to 1986 inclusive, are

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[21] Residual autocorrelations are assumed to be normally distributed random variables with zero mean and variance of 1/T where T is the number of observations in the time series. This figure is represented as

$$\hat{r}_k = \sum_{t=1}^{T} \hat{e}_t \hat{e}_{t+k} \Big/ \sum_{t=1}^{T} \hat{e}_t^2 \text{ (Box and Jenkins, 1976).}$$

from the Winnipeg Commodity Exchange and were obtained from the I.P. Sharp data tape of the AGDATA Agricultural Commodities Data Base.[22] Daily price data from the annual Chicago Board of Trades' Commodity Futures Data Tape provided the price series for seven contract months of soybeans and eight contract months for soymeal and oil over the successive four year period.[23]

Four years of rapeseed daily closing prices covering all contracts were used in this study. Two different series of data were used to represent futures prices of soybeans and products as the recording procedure for the Chicago Board of Trade was not consistent over the four year period that is studied. The first or only price of the closing price range was used for all 1983 contracts, while the settlement price was used for the remaining contract years. This inconsistency is relatively unimportant to the study as the two reported prices were basically the same series under different names. A settlement price is a single price chosen from a possible range in the closing prices. The only time the two price series would be different is if there is a range reported for the closing prices, and even then the settlement price would still be within this range. Throughout the one year period studied where the first or only price of the closing price range is used there are few cases where a second closing price is reported.

Missing data points are an inherent problem when attempting to compile a large data set from various sources. The largest problem is due to non-concurrent American and Canadian holidays. Approximately thirty-five days over the four year period are missing from the various series. Since there are only four cases where more than one data point in a row was missing in a row, the problem is managable. Since no transactions could take place on the days that had no reported prices, market participants would be unable to change their position in the marketplace until the next day that the exchange was in operation. The missing data points are treated in a manner that would represent the situation facing market participants.

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[22] The canola contract months for which data are available and were analyzed were for January, March, June, September and November futures contracts.

[23] Soybean contracts included January, March, May, July, August, September and November contracts. The soymeal and soyoil contracts included January, March, May, July, August, September, October and December futures contracts.

The price reported for the missing data point is taken to be the price that is reported for the next day of exchange operation. In handling the data in this manner, the lag structure of the series is not affected as each week of the observed time period has five consecutive data points representing the five working days.

In the analysis of the lead-lag structure of prices for Canadian canola and American soybeans and products, the price data were not adjusted to compensate for changes in the exchange rate between Canada and the United States. The objective of the study was to generate information concerning the existence, magnitude and direction of the relationships between the Alberta street prices for canola and the Chicago Board of Trade's futures prices for related commodities. It is anticipated that if changes in the exchange rate affect Canadian street prices for canola, this would be one factor among many affecting Canadian street prices. An attempt to isolate and quantify the specific influence of such variables that might contribute to any lead-lag relationships is outside the scope of this report.

Model Application

Diagnostic checks for autocorrelation and stationarity of the data were performed as the first step in applying the model. The properties of each data series were observed by generating data plots and autocorrelation functions.[24] Examinations of the data plots demonstrated trends associated with specific time periods and the correlograms demonstrated that the original data series generally exhibited properties suggesting evidence of non-stationarity.[25]

The data series were differenced in an attempt to induce stationarity. Differencing involves a process in which the value from the past time period is subtracted from the value of the current time period.[26] The process of first differencing resulted in a new series of

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[24] An autocorrelation function is the normalized autocovariance function which measures the linear dependence between members of a single time series (Judge *et al.*, 1980).

[25] A stationary time series will exhibit truncation of the autocorrelation functions, while the autocorrelation of a nonstationary series will attenuate, or diminish very slowly even at high lag values (Benson and Faminow, 1987).

[26] The process described above is that of first differencing. While it is possible to

transformed data that represented the absolute price change from period to period rather than the price of the product during the period.

Comparison of the correlograms and data plots, as well as Goldfeld-Quandt tests conducted to test for heteroskedasticity were performed on first and second differenced data series and demonstrated that first differencing was sufficient to generate a stationary time series.[27] After each of the data series had been reduced to white noise, the next step was to determine the appropriate number of lags required to filter the autocorrelation from the various series. Values from each series were regressed upon past values of themselves to determine the required lag length. The presence of significant autocorrelation was tested for using the Ljung-Box Q-statistic (Equation 3.5). Although no one lag length was appropriate for all the series, only four series required more than five lags to filter the series at the 1 percent level of significance as tested by the Ljung-Box Q-statistic. Further study indicated that the autocorrelation problem in these series could not be overcome without resorting to an inordinate number of lags. Results from equations exhibiting significant autocorrelation were not further considered in the analysis.[31]

It was decided that all dependent and independent variables would be lagged five times in the equations modeling lead-lag structure. As a result of this specification, the terms k and m in equations 3.1, 3.2, 3.4, and 3.5 took a constant value of five. This permitted testing for a symetric response between futures and cash price changes, and also conforms to the considerations of short-term market dynamics that market analysts believe are perceived by market participants (Garcia, Leuthold and Zapata, 1986).

Geweke tests, as specified in equations 3.1, 3.2, and 3.3, were performed on the data, with y representing the A.W.P. daily street price series and x representing, successively, the W.C.E. rapeseed futures contracts and C.B.O.T. soybean, soyoil and soymeal futures contract prices. F-statistics and Q-statistics for equations testing for temporal and contemporaneous

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[26](cont'd) difference data by a higher order, the process of generating first differences is generally sufficient to induce stationarity.

[27] From this point the first differenced series will be referred to as the data series.

[31] All hypotheses in this analysis were tested at a 5 percent level.

causality are reported in table form.[29] The actual regression results presenting the coefficients and the coefficient of determination for each regression are included in Appendix A of the study.

[29] Since the data represents daily changes in various price series, evidence of instantaneous causality would suggest that the adjustment is being made within one day.

IV. Empirical Results of the Lead-Lag Analysis

Results from the Geweke tests conducted for this study are presented here in four successive sections. The first section contains results of the tests for lead-lag relationships between canola futures prices and street prices of canola. The results of the evaluation of lead-lag tests for relationships between Amercian soybean and soy product prices and Western Canadian canola street prices are discussed in sections two, three and four of this chapter.

A. Farm Gate to Rapeseed Futures Price Linkage

Five separate rapeseed futures contracts, each associated with delivery in a particular contract month, are traded on the Winnipeg Commodity Exchange. Geweke (OLS) tests are conducted for each contract to test for one-way, instantaneous or feedback relationships between these price series and the AWP street price series for the period from 1983 to 1986. The results of the tests on 1983 data are given in Table IV.1 and A.1.

The results in Table IV.1 demonstrate that problems with autocorrelation at a 5 percent level of significance exist for both temporal (that is, one way causality) and contemporaneous tests (instantaneous causality) of street prices leading the September and November rapeseed contract prices. F-statistics for the remaining eight equations demonstrate rejection of the null hypothesis of no instantaneous correlation between the price series at the 5 percent level. Futures contract prices appear to lead street prices for all five contracts and feedback did not appear to occur. Coefficients of determination, given in Table A.1, show that the lagged canola futures price variables explained from 33 percent to 48.3 percent of the total variation in street prices for the tested contracts. Little of the variation in canola futures prices is explained by the street prices of this commodity. In the regressions in which the street price is the dependent variable, coefficients on all lagged dependent variables, the same day futures price variables (that is, the instantaneous independent variable) and the futures price variables lagged one period and two periods are significant. The results seem to suggest that one way causality from the futures prices to the street prices appears to exist and that street prices tend to adjust rapidly to changes in futures prices.

Table IV.1

One-Way And Instantaneous Causality Test Results for Geweke Tests on 1983 Rapeseed Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	*6.00	10.56	*17.73	7.55
Mar→Str	*7.08	11.66	*16.55	6.93
June→Str	*4.38	21.17	*11.46	17.79
Sept→Str	*8.95	18.84	*44.28	13.65
Nov→Str	*9.07	14.83	*67.90	13.82
Str→Jan	0.61	42.74	*17.73	43.93
Str→Mar	0.4[illegible]	37.43	*16.55	46.41
Str→June	0.45	40.47	*11.46	43.36
Str→Sept	0.41	*88.05	*44.29	*67.61
Str→Nov	0.23	*91.62	*67.90	*62.33

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

The results of the tests on 1984 rapeseed contracts and corresponding street prices of canola are given in Tables IV.2 and A.2. In view of the larger than normal fluctuations in the June contract price (from $405/tonne in March to $724/tonne in May) the test results for this contract month are considered suspect and not interpreted. The remaining relationships exhibit one-way lead-lag relationships from futures prices to street prices as well as instantaneous relationships. There are no significant one-way relationships from the street prices to futures prices. The equation representing the test of an instantaneous relationship for Jan→Str[30] has a coefficient of determination of 60.8 percent, however the t-statistics for the estimated coefficients indicate that two lagged independent variables, as well as the variable representing the same day value of the January futures prices and all five lagged dependent variables are significant. In the two tests of the significance of the relationship Mar→Str, all but one lagged variable is significantly different from zero. [31]

Instantaneous causality is demonstrated in all of the lead-lag relationships between 1985 rapeseed futures contract prices and corresponding canola cash prices. The results from these tests are in Table IV.3 and A.3. One-way causal structure is also evident for Jan→Str, June→Str and Str→Mar. The latter is the first occurence in this study of one-way statistical time ordered association from street prices to futures contract prices. Although the coefficient of determination for the contemporaneous relationships of Jan→Str, June→Str and Sept→Str exceeds 56 percent, fewer lagged variables are significant than in tests on 1984 data.

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[30] As seen on pages 25 and 26 there is a specific notation for the various possible test results. Geweke tests performed in this study analysed relationships between street prices for canola and futures prices for rapeseed, soybeans, soymeal and soyoil. For the purpose of this study, the two series being analysed will be represented by a particular notation. Street prices will be denoted by the prefix Str, while the corresponding futures prices will be represented by a recognizable abbreviation of the futures contracts expiry month. An arrow will indicate the direction of the lead-lag relationhip that is being tested.

[31] The Geweke model, which is dynamic in nature, is estimated in such a manner that the number of significant lagged coefficients does not provide information about a testable hypothesis. The significance of lead-lag relationships is evaluated using the Geweke test (F-statistic) in which the significance of the entire lag structure is tested. Information concerning the coefficients of determination and the significance of individual lagged variables is provided only with the intention of demonstrating interesting trends which seem to be apparent in the results.

Table IV.2

One-Way And Instantaneous Causality Test Results for Geweke Tests on 1984 Rapeseed Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	*6.67	35.41	*242.88	9.65
Mar→Str	*7.38	38.46	*64.69	47.19
June→Str	0.01	30.40	1.37	30.96
Sept→Str	*6.13	51.84	*85.06	56.64
Nov→Str	*4.86	54.02	*77.27	65.05
Str→Jan	0.04	64.68	*242.88	38.70
Str→Mar	0.54	37.21	*64.69	27.72
Str→June	*2.45	12.97	1.37	13.17
Str→Sept	0.41	53.74	*85.06	43.67
Str→Nov	0.15	45.80	*77.27	57.20

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.3

One-Way And Instantaneous Causality Test Results for Geweke Tests on 1985 Rapeseed Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[1]
Jan→Str[4]	*2.64	45.62	*227.04	56.95
Mar→Str	0.75	39.48	*41.12	33.19
June→Str	*3.50	32.82	*298.44	71.66
Sept→Str	1.99	41.98	*270.83	12.66
Nov→Str	2.03	45.73	*127.08	60.99
Str→Jan	1.00	61.33	*277.06	54.12
Str→Mar	*2.61	15.99	*41.12	6.66
Str→June	0.78	45.21	*248.54	55.27
Str→Sept	0.25	*80.20	*270.83	43.55
Str→Nov	1.59	56.41	*127.08	56.96

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Only two significant one-way lead-lag relationships are demonstrated by tests on 1986 rapeseed futures prices and canola street prices. As seen in Tables IV.4 and A.4, all ten contemporaneous relationships are significant. Autocorrelation is not a problem, there is no evidence of feedback and the equations representing the instantaneous relationships have high coefficients of determination.

There is an interesting feature of the F-statistics testing for instantaneous causality from the futures market to the street price, and the value of the same statistic for the corresponding tests in which the futures price is considered as the dependent variable. In every case throughout the four year period studied, the two F-statistics have almost the same value when rounded off to three decimal places. This suggests that the addition of the instantaneous component to the Geweke model has the same significance or influence on the equations, regardless of the direction of causality being tested for.

B. Relationships Between Soybean Futures Prices and Canola Street Prices

This section reviews the results from Geweke tests estimating possible lead-lag relationships between the street prices of canola and the prices of each of the seven futures contract months for soybeans between 1983 and 1986. The results from applying Geweke tests to the 1983 data are given in Tables IV.5, A.5 and A.6. Table A.5 contains the regression coefficients from bivariate causality testing of temporal relationships, while Table A.6 reports similar statistics from the tests for instantaneous relationships. The results in Table IV.5 demonstrate that there is a problem with autocorrelation in three separate equations (Str→Sept, Str→Nov and Str↔Nov). The analysis therefore excludes these three cases. Feedback was not apparent in any of the equations modeled. Table IV.5 also indicates that all seven tests of lead-lag relationships from the 1983 soybean futures price to the canola street price demonstrate significant F-statistics. Results from all thirteen of the Geweke tests of contemporaneous correlation indicate a rejection of the null hypothesis of no instantaneous relationship.

Table IV.4

One-Way And Instantaneous Causality Test Results for Geweke Tests on 1986 Rapeseed Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	1.26	51.42	*305.71	60.35
Mar→Str	1.61	58.79	*308.72	56.54
June→Str	*2.93	43.72	*448.51	39.20
Sept→Str	1.08	35.11	*471.24	24.13
Nov→Str	0.49	34.76	*1152.39	31.98
Str→Jan	0.59	46.84	*305.71	32.83
Str→Mar	0.51	38.62	*308.70	31.72
Str→June	0.43	40.62	*448.00	38.29
Str→Sept	*4.43	39.32	*471.24	23.78
Str→Nov	0.46	50.03	*1152.39	38.17

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.5

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1983 Soybean Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	*2.26	11.74	*18.09	12.70
Mar→Str	*2.47	11.98	*19.60	12.23
May→Str	*2.37	14.71	*22.31	12.81
July→Str	*2.44	11.53	*25.62	11.04
Aug→Str	*3.88	11.57	*28.21	10.77
Sept→Str	*4.67	12.48	*29.64	7.66
Nov→Str	*4.79	14.34	*37.18	10.51
Str→Jan	0.18	48.67	*18.01	46.52
Str→Mar	0.28	42.01	*19.59	38.76
Str→May	0.17	50.17	*22.31	51.58
Str→July	0.26	37.83	*25.60	43.73
Str→Aug	0.38	46.41	*28.20	46.63
Str→Sept	0.32	*74.06	*29.61	64.94
Str→Nov	0.70	*141.54	*37.10	*106.63

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

From the results in Table IV.5 it can be seen that variables representing lagged canola street prices, with two exceptions, and once-lagged rapeseed futures prices exhibit significant coefficients in the tests of lead-lag relationships from future prices to street prices. The variables representing the instantaneous component are significant throughout the thirteen tests that are analysed.

Close observation of the results of the lead-lag tests on four years of soybean futures prices and canola street price relationships (Tables IV.5 to IV.8, and Tables A.5 to A.12), demonstrates an interesting trend. From 1984 on, F-statistics testing the existence of one-way lead-lag relationships show no evidence of significant relationships. However, the F-statistics testing for contemporaneous lead-lag behavior continue to be significant. This tendency can also be seen in Tables A.7 to A.12. There are fewer significant coefficients on the lagged dependent and independent variables in the last two years of the time period studied. However, all the coefficients representing the instantaneous variable continue to be significant throughout the time period. The coefficients of determination from the models testing one-way lead-lag relationships become smaller in the later years.

C. Relationships Between Soyoil Futures Prices and Canola Street Prices

Geweke test results from the estimation of possible lead-lag relationships between the street price for canola and the prices from all eight futures contract months for soyoil are reviewed in this section. Once again, the data covered the four year period from 1983 to 1986. Regression coefficients and the resulting F-statistics, Q-statistics and regression results including the coefficients of determination are presented in Tables IV.9 to IV.12, and Tables A.13 to A.20.

The tendencies demonstrated in the results of lead-lag tests between soybean futures prices and canola street prices are also evident in the results from tests between soyoil futures prices and canola street prices. F-statistics demonstrate significant one-way causal relationships running from soyoil futures prices to canola street prices for the 1983 contract data. Both the number of significant coefficients, and the size of the coefficients of

Table IV.6

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1984 Soybean Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	*4.34	12.14	*27.09	10.05
Mar→Str	*2.98	41.32	*48.60	47.91
May→Str	*2.58	51.26	*53.21	49.03
July→Str	*2.64	46.94	*70.71	39.18
Aug→Str	1.94	46.02	*60.86	40.74
Sept→Str	1.75	41.14	*47.41	38.69
Nov→Str	1.27	47.09	*40.60	43.54
Str→Jan	0.51	*94.67	*27.01	*69.81
Str→Mar	1.02	*78.10	*48.44	*71.99
Str→May	0.39	*70.90	*53.11	62.50
Str→July	0.42	57.88	*70.64	49.36
Str→Aug	0.33	58.40	*60.06	47.55
Str→Sept	0.28	51.65	*47.14	48.33
Str→Nov	0.28	54.96	*40.56	52.90

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.7

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1985 Soybean Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	1.41	46.15	*29.37	48.46
Mar→Str	1.90	37.33	*27.37	33.30
May→Str	0.52	60.72	*75.25	*71.15
July→Str	0.28	48.88	*72.17	58.08
Aug→Str	0.95	50.63	*82.55	44.97
Sept→Str	0.98	32.79	*56.33	38.00
Nov→Str	1.47	40.75	*59.43	36.49
Str→Jan	0.19	46.31	*29.32	51.90
Str→Mar	1.00	50.82	*27.30	56.20
Str→May	0.94	56.23	*75.20	*72.52
Str→July	0.70	58.10	*72.12	*68.16
Str→Aug	1.75	42.13	*82.42	50.66
Str→Sept	0.99	52.00	*56.31	45.39
Str→Nov	0.47	46.27	*59.40	41.13

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str. while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.8

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1986 Soybean Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	1.25	58.80	*79.03	46.83
Mar→Str	1.18	56.50	*76.35	48.60
May→Str	1.49	60.16	*93.29	50.17
July→Str	1.11	62.99	*108.45	46.01
Aug→Str	1.18	53.80	*135.11	57.70
Sept→Str	1.15	39.59	*102.03	40.54
Nov→Str	1.20	44.35	*123.24	43.83
Str→Jan	1.22	43.26	*79.03	45.52
Str→Mar	1.05	44.92	*76.34	45.65
Str→May	0.77	42.50	*93.29	52.21
Str→July	0.62	42.96	*108.46	58.51
Str→Aug	0.42	28.16	*135.11	58.14
Str→Sept	0.62	37.71	*102.04	40.49
Str→Nov	0.57	46.85	*123.23	56.16

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.9

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1983 Soyoil Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	*2.50	10.70	*14.76	11.11
Mar→Str	*2.81	14.83	*16.49	15.04
May→Str	0.15	9.45	*10.04	9.55
July→Str	*2.35	10.94	*15.51	11.89
Aug→Str	*3.54	13.29	*17.94	12.93
Sept→Str	*4.24	14.96	*34.15	12.05
Oct→Str	*3.94	13.72	*35.84	10.61
Dec→Str	*4.62	16.90	*27.00	12.85
Str→Jan	0.00	45.38	*15.99	42.21
Str→Mar	0.46	39.86	*17.03	40.64
Str→May	0.14	32.95	*10.06	32.87
Str→July	0.46	18.98	*14.37	18.66
Str→Aug	0.59	55.64	*17.21	45.76
Str→Sept	0.16	*102.04	*34.80	65.02
Str→Oct	0.75	*104.44	*35.63	*77.50
Str→Dec	0.42	*117.42	*27.37	*86.64

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.10

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1984 Soyoil Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	*4.40	13.29	*30.12	14.52
Mar→Str	*3.46	46.26	*56.27	58.39
May→Str	*2.65	45.87	*55.09	47.11
July→Str	*2.37	45.19	*68.03	44.27
Aug→Str	1.21	43.37	*49.91	42.81
Sept→Str	1.49	40.85	*33.78	38.27
Oct→Str	1.72	42.72	*21.40	40.59
Dec→Str	1.58	49.75	*20.68	45.03
Str→Jan	0.09	*92.62	*29.99	*68.22
Str→Mar	0.49	*78.97	*56.34	62.06
Str→May	*2.53	*69.21	*32.21	54.87
Str→July	0.71	51.55	*68.10	40.15
Str→Aug	0.56	57.90	*49.92	49.07
Str→Sept	0.80	48.28	*33.67	50.05
Str→Oct	0.25	38.74	*21.40	40.06
Str→Dec	0.18	43.25	*20.61	51.57

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.11

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1985 Soyoil Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	1.56	22.40	*17.74	16.19
Mar→Str	0.20	45.86	*43.01	42.96
May→Str	0.51	44.14	*51.07	38.47
July→Str	0.23	55.65	*61.23	53.40
Aug→Str	0.87	47.01	*38.26	51.84
Sept→Str	0.58	52.10	*53.48	51.19
Oct→Str	0.50	56.97	*54.41	52.10
Dec→Str	0.36	55.24	*63.41	50.18
Str→Jan	0.21	53.82	*17.84	62.22
Str→Mar	0.61	36.75	*42.87	44.35
Str→May	0.83	38.43	*50.76	46.37
Str→July	1.25	51.10	*61.27	56.65
Str→Aug	1.00	58.34	*54.86	48.81
Str→Sept	*2.68	64.06	*53.14	52.80
Str→Oct	2.21	*68.69	*53.69	61.60
Str→Dec	2.18	50.63	*63.50	49.34

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.12

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1986 Soyoil Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	0.48	57.60	*52.61	54.44
Mar→Str	0.50	51.28	*49.60	46.70
May→Str	0.60	47.03	*90.61	45.18
July→Str	0.52	39.93	*103.40	38.09
Aug→Str	1.37	45.68	*24.68	46.47
Sept→Str	1.04	43.23	*98.53	34.50
Oct→Str	*3.90	34.81	*154.69	28.68
Dec→Str	*4.07	50.19	*170.41	31.98
Str→Jan	1.81	41.57	*51.69	34.09
Str→Mar	1.41	41.22	*50.09	39.55
Str→May	0.21	54.14	*91.33	44.84
Str→July	0.25	55.63	*102.70	46.73
Str→Aug	1.89	21.63	*24.54	22.32
Str→Sept	0.61	37.58	*98.10	40.56
Str→Oct	0.59	36.67	*155.11	53.41
Str→Dec	1.39	44.56	*168.59	55.75

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.13

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1983 Soymeal Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	1.59	10.78	*14.45	11.82
Mar→Str	1.38	12.47	*14.95	12.42
May→Str	1.35	11.10	*11.63	11.02
July→Str	1.52	10.87	*15.10	10.17
Aug→Str	*2.82	11.88	*18.05	11.19
Sept→Str	*3.05	13.70	*15.32	8.00
Oct→Str	*2.93	11.80	*15.77	8.29
Dec→Str	*4.20	11.67	*16.50	8.38
Str→Jan	0.58	39.09	*14.44	39.89
Str→Mar	0.38	41.41	*14.97	50.90
Str→May	0.29	35.67	*11.64	42.42
Str→July	0.27	37.66	*15.11	43.48
Str→Aug	0.40	47.12	*18.07	46.17
Str→Sept	0.46	61.91	*15.32	56.59
Str→Oct	0.90	*98.43	*15.77	*83.94
Str→Dec	0.41	*119.03	*16.50	*96.41

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.14

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1984 Soymeal Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	*2.97	11.66	*16.65	8.81
Mar→Str	*2.97	44.12	*33.29	44.34
May→Str	*2.42	45.40	*25.93	45.50
July→Str	*2.45	46.95	*36.91	44.71
Aug→Str	1.73	45.51	*42.99	40.84
Sept→Str	1.87	37.95	*28.26	36.38
Oct→Str	0.90	38.32	*13.34	38.15
Dec→Str	1.81	45.26	*17.05	43.82
Str→Jan	0.52	*88.33	*16.65	67.09
Str→Mar	0.97	64.83	*33.29	57.21
Str→May	0.69	*68.54	*25.93	57.28
Str→July	0.26	65.93	*36.91	54.02
Str→Aug	0.13	*97.37	*42.99	*77.87
Str→Sept	0.14	44.63	*28.26	44.17
Str→Oct	0.27	54.46	*13.34	45.60
Str→Dec	0.48	53.59	*17.05	50.06

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.15

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1985 Soymeal Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[3]
Jan→Str[4]	1.85	42.65	*16.59	42.13
Mar→Str	*2.43	21.91	*10.80	17.79
May→Str	1.66	37.95	*18.79	35.88
July→Str	0.74	52.51	*33.59	57.95
Aug→Str	1.68	37.91	*24.66	39.63
Sept→Str	0.88	43.02	*10.51	41.48
Oct→Str	1.24	52.29	*10.05	50.81
Dec→Str	0.94	49.74	*16.13	51.08
Str→Jan	0.33	50.06	*16.58	44.29
Str→Mar	0.67	52.14	*10.83	54.76
Str→May	0.72	39.67	*18.78	42.99
Str→July	1.01	26.70	*33.62	26.99
Str→Aug	1.41	38.19	*24.65	35.43
Str→Sept	1.60	41.14	*10.50	39.19
Str→Oct	0.78	33.79	*10.06	30.58
Str→Dec	1.04	38.71	*16.00	34.65

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

Table IV.16

One-Way and Instantaneous Causality Test Results for Geweke Tests on 1986 Soymeal Futures Contracts and AWP Canola Street Prices

	One-Way Causality		Instantaneous Causality	
	F-statistic[1]	Q-statistic[2]	F-statistic[3]	Q-statistic[2]
Jan→Str[4]	1.21	50.79	*14.51	52.67
Mar→Str	0.82	55.09	*17.28	57.45
May→Str	0.55	46.04	*23.07	49.84
July→Str	0.33	51.04	*33.45	50.41
Aug→Str	0.80	37.60	*38.03	50.99
Sept→Str	0.96	32.67	*38.40	48.08
Oct→Str	1.29	43.29	*54.48	43.27
Dec→Str	1.14	45.78	*49.58	49.71
Str→Jan	0.26	23.99	*14.53	22.93
Str→Mar	0.50	35.07	*17.28	33.76
Str→May	0.41	34.93	*23.09	38.28
Str→July	0.55	39.16	*32.42	43.44
Str→Aug	0.50	42.11	*38.00	45.53
Str→Sept	0.15	32.89	*38.40	34.71
Str→Oct	0.31	45.21	*54.50	47.36
Str→Dec	1.12	49.86	*49.57	47.91

[1] F-statistic is approximately $F_{.05}$ (5,200). The critical value = 2.26.

[2] Q-statistic is $Q_{.05}$ (50). The critical value = 67.50.

[3] F-statistic is $F_{.05}$ (1,200). The critical value = 3.89.

[4] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* Indicates statistical significance at the 5 percent level.

determination follow declining trends over the period observed (Table A.13). F-statistics for tests of instantaneous causal relationships were significant throughout the time period as were the coefficients representing the instantaneous variable in the Geweke equations. One instance of feedback is evident in the results. This case and the eight regressions demonstrating significant autocorrelation are not considered further in the analysis.

D. Relationships Between Soymeal Futures Prices and Canola Street Prices

This section summarizes the results from Geweke tests examining the lead-lag relationships between canola street prices and American soymeal futures prices for the time period from 1983 to 1986. The regression coefficients, F-statistics, Q-statistics and coefficients of determination are presented in Tables IV.13 to IV.16, and Tables A.21 to A.28.

The results presented in Tables IV.13 to IV.16 demonstrate that instantaneous interdependence is the best way of expressing the temporal relationships between canola prices and soymeal futures prices during the time period studied. There is some evidence to suggest significant one-way causality from the soymeal futures prices to the canola street prices in the first three years tested, however, there are no significant one-way lead-lag relationships evident for 1986. F-statistics from tests for contemporaneous relationships are all significant throughout the time period studied. There are no apparent problems with autocorrelation in the 1985 and 1986 data and only eight cases are reported for the first two years of the analysis.

Although the value for F-statistics measuring the significance of the contemporaneous relationships seem to trend upwards, the coefficients of determination of these relationships display a downward trend. All the coefficients representing the instantaneous component of the Geweke equation are significant throughout the entire observed period.

V. Discussion of the Results from Tests of Lead-Lag Relationships

The results from Geweke tests described in Chapter 3 of this report are discussed in this chapter. Western Canadian canola street price relationships with rapeseed futures market prices are discussed first. This is followed by an analysis of the relationship between Western Canadian canola street prices and soybean, and product futures contract prices between 1983 and 1986.

A. Geweke Results

Linkage Between A.W.P. Street Prices and Rapeseed Futures Prices

The results of testing the lead-lag relationship between the price for rapeseed contracts on the Winnipeg Commodity Exchange between 1983 and 1986 and the corresponding A.W.P. street prices for canola were given in Tables IV.1 to IV.4, and A.1 to A.4. Scrutiny suggests the existence of four specific trends that can be delineated from the tests of the relationship between rapeseed futures prices and canola street prices.

First, values of the coefficients of determination are declining in the equations estimating one-way causal structure between the two price series. These values, found in the last column in Tables A.1 through A.4, are measures of the goodness of fit of the given regression equations. The fall in R^2 from 1983 to 1986 is more evident in equations testing for lead-lag structure with rapeseed futures prices leading canola street prices; however, there is also a fall in the levels of the coefficients of determination for equations testing for causal structure in the opposite direction.

A coefficient of determination is expressed as the ratio of the explained sum of squares, to the total sum of squared deviations for the dependent variable of a particular regression (Johnston, 1984). As the lagged independent and dependent variables explain more of the variation of the dependent variable, the value of the R^2 increases. The downward trend in the value of the R^2 for equations modeling relationships between canola street prices and rapeseed futures contract prices from 1983 to 1986 may suggest that the ability of the lagged

futures and street prices to account for daily variation in the value of the dependent price series is diminishing over time.

Secondly, there appears to be an increasing trend in the coefficients of determination (R^2) from the equations testing for contemporaneous relationships between the two price series for the time period studied. This trend is demonstrated in Table V.1. Due to the large number of equations in the analysis, mean values of the coefficients of determination from Geweke equations testing for instantaneous causality are provided as a summary of explanatory power of these equations. Mean values are calculated from the series of R^2 for relationships between A.W.P. canola street prices and futures prices for rapeseed, soybeans, soyoil and soymeal for 1983, 1984 and 1986. The R^2 used in the calculations are given in Tables A.1 to A.28 in Appendix B. The mean value of the R^2 from the Geweke tests of instantaneous causality between rapeseed futures prices and canola cash prices rises from 45.5 in 1983 to 66.8 in 1986, an increase of 46.9 percent over the four year period studied. Thus an average of 66.8 percent of the variation in canola street prices and rapeseed futures prices contract is explained by the eleven variables included in each of the equations testing for contemporaneous, or instantaneous lead-lag relationships in 1986.

This increase in the mean level of the R^2 can be attributed to the significance of the instantaneous component in the regressions. The results in Tables A.1 to A.4 demonstrate that the instantaneous variable representing the same day price of the independent variable is significant in 95 percent of the Geweke equations testing for contemporaneous relationships. It appears that in these estimated equations the declining explanatory power of the lagged dependent and independent variables is more than offset by the influence of the variable representing the instantaneous relationship. The results suggest that the same day value of the independent price series is of increasing importance over the period studied.

The third general tendency observed in the results concerns the number of significant Geweke equations testing for one-way causal structure. Table IV.1 presents results demonstrating five significant F-statistics for Geweke tests of one-way causal structure between rapeseed futures prices and canola cash prices using 1983 data. Results using 1986

Table V.1

Mean Values of the R^2 from Geweke Equations Testing for Instantaneous Lead-Lag Relationships Between the Futures Market Price for Soybeans, Oil, Meal and Rapeseed Contracts, and A.W.P. Canola Street Prices[1]

Year	Rapeseed↔Str[2] Mean R^2	Soybeans↔Str Mean R^2	Soyoil↔Str Mean R^2	Soymeal↔Str Mean R^2
1983	45.5[3]	28.8[5]	34.5[7]	32.1[9]
1986	66.8[4]	28.7[6]	29.1[8]	15.9[10]

[1] Mean values of the coefficients of determination for the four relationships analysed in this table are calculated using the R^2 given in Tables A.1 to A.28 in Appendix A.

[2] A↔B is the notation representing Geweke lead-lag equations testing the significance of the instantaneous relationship between price series A and price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract being tested is referenced by commodity name.

[3] R^2 used in the calculation of this figure are in Table A.1.

[4] R^2 used in the calculation of this figure are in Table A.4.

[5] R^2 used in the calculation of this figure are in Table A.6.

[6] R^2 used in the calculation of this figure are in Table A.12.

[7] R^2 used in the calculation of this figure are in Table A.14.

[8] R^2 used in the calculation of this figure are in Table A.20.

[9] R^2 used in the calculation of this figure are in Table A.22.

[10] R^2 used in the calculation of this figure are in Table A.28.

data, given in Table IV.4, show evidence of only two significant one-way relationships (June → Str, and Str → Sept). The decreasing number of significant F-statistics testing for one-way causality combined with the downward trend in the values of the R^2 signify a decline in the importance of lagged rapeseed futures prices and lagged A.W.P. street prices in price formation for both futures prices and street prices.

A fourth observation can be made from the test results. This observation concerns the significance of the majority of F-statistics from the regressions testing for instantaneous causality between rapeseed futures prices and canola street prices. Ninety-five percent of all the regressions that included the variable representing the same day price for the rapeseed futures contract prices or canola street prices were significant using the Geweke tests. Specifically, when the canola street price is the dependent variable, the non-lagged, or same day, price for a rapeseed futures contract is a significant factor in the equation estimating the value of the canola street price. When rapeseed futures prices are the dependent variables, the same day values of canola street prices are significant in the estimating regressions. This suggests a close relationship between Western Canadian canola street prices and prices for the rapeseed futures contracts.

Increasing interdependence observed between the formation of rapeseed futures contract prices and A.W.P. street prices has a number of probable causes. Major structural changes in the world market for oilseeds and markets for Canadian cereals and oilseeds occurred between 1983 and 1986. A discussion of these changes may provide some insight into results from Geweke tests on relationships between canola street prices and rapeseed futures contract prices in this time period.

One important factor affecting Canadian oilseeds was a change in the rail rate structure intended to facilitate the transportation, shipping and handling of Western Canadian cereals and oilseeds. In May 1983, Bill C-155 was introduced in the House of Commons reflecting the Federal Government's intentions to change the previous long-standing statutory rail rates (Normile, 1983). These amendments to the statutory rail rates for grain and oilseeds effectively lowered the transport costs for canola products, and included canola oil, meal and

Table V.2

Winnipeg Commodity Exchange Rapeseed Futures Contract Trading Volumes for the Period from 1983 to 1986

Contract	Annual Volume of Units of Trade (20 Tonne Units) 1983	1984	1985	1986
June	138,785	161,331	220,509	203,566
Sept.	132,550	110,265	184,637	196,524
Nov.	178,397	198,450	244,338	274,093
Jan.	105,295	140,831	153,336	161,286
March	114,024	135,246	162,452	146,236
Total	669,051	746,623	965,272	981,705

Source: Based on Trading Volumes reported in Table 40 of the Canadian Grains Council, *Canadian Grains Industry Statistical Handbook*. Canada Grains Council, Winnipeg, 1987: 171-173.

oil cake under the schedule 1 transport price scale. Raw canola is also transported under a schedule 1 transport price scale (The Western Producer, 1983).

Under the old Crow rate provisions, raw canola for export was shipped to Vancouver or Thunder Bay by rail at the statutory rate as was canola seed shipped for domestic use. Rail shipments of canola oil and meal were charged commercial transport rates. In general, it is expected that the value of canola to producers would have been affected by the levels of port (Vancouver) price for canola minus transportation, handling and holding costs. The total freight rate was a function of the transport distance and a particular base rate scale associated with mileage travelled. The net producer share of the total freight rate was calculated by subtracting the portion of the total freight rate paid by the Federal Government per tonne shipped, from the total freight rate per tonne shipped. Statutory rail rates lower the transport costs to canola producers below the actual rail freight rate by the amount of the Federal Government subsidy (The Western Producer, 1983).

The value of canola to the processor is a function of transportation costs as well as the prices received at the export position for canola products, minus the processing costs, initial purchase price for the raw canola. The Crow rate system, thus is expected to have distorted the value of canola to the processor in two ways:

1. The price paid by the crusher for locally available raw canola could have been artifically high, because transport costs to port price positions were artificially low.
2. Processor's crushing margins could have been artificially decreased due to the relatively high cost of shipping canola products as compared to the low transport costs affecting the price of inputs (Normile, 1983; Perkins, 1976).

The Western Grain Transportation Act came into effect January 1, 1984. Under the new agreement, canola, canola oil and canola meal all fall under the same schedule of transport costs. Under the new rail rate legislation, the rail transport costs for canola seed and canola products paid by producers and processors are the same. To this extent, one expects that the removal of a market distortion would lead to a more efficient price establishment mechanism (Caves, 1982; Green, 1985).

Fama's (1970) discussion of efficient capital markets suggested that rapid information transmission is one component of an efficient market. Observation of the relevant F-statistics and coefficients of determination from the Geweke tests performed on the relationship between A.W.P. canola street prices and rapeseed futures contract prices suggest that the speed of information transmission may have improved over the four year period studied. The change in freight rate policy may have been one factor contributing to the apparent increased market efficiency suggested by the results of Geweke tests.

A second domestic factor which may have been of importance to the pricing of canola in Canada is the increase in the liquidity and apparent maturity of the rapeseed futures market over the four year period tested. Rapeseed futures trading commenced in 1963 and empirical tests performed on data from the first decade of operation seemed to indicate inefficiency in the form of a downward price bias (Martin and Story, 1975). More recent tests by Veeman and Moreau (1985) suggested that this tendency was subsequently not evident in

the rapeseed futures market.

Data on the volume of trading in rapeseed futures contracts on the Winnipeg Commidity Exchange indicate a 46.7 percent increase between 1983 and 1986 suggesting that the rapeseed futures market has continued to mature since the 1985 study (Canada Grains Council, 1987).[32] The increasing volume of trading in rapeseed futures contracts would have added to the liquidity and the liklihood of arbitrage occuring in canola price establishment. More interdependent and instantaneous price formation between rapeseed futures contract prices and canola cash prices may have resulted from the apparent increased maturity of the rapeseed futures market between 1983 and 1986.

A third factor which may have influenced lead-lag tests on A.W.P. canola street prices and rapeseed futures contract prices is the change in world oilseed markets that has taken place over the past five years. The world market for oilseeds has become very competitive. High production input costs combined with lower product price levels have squeezed profit margins. As was outlined in Chapter three, price indexes for vegetable oils and protein meal rose 26 percent between 1982 and 1984, but declined by 25 percent in 1985 and by a further 15 percent in 1986 (U.S.D.A., 1986). Demand for oilseeds has risen every year since 1980, although at a lower rate than for the increase in production. Large increases in palm oil production from Malaysia and Indonesia, combined with increased world production of rapeseed and the lowest real oilseed prices since the 1930's, have led to increased competition in offshore oilseed sales. It is possible that consequent financial pressures may have resulted in efficiency gains in Canada's canola production and processing sector. Increased competition may have resulted in faster information transfer concerning canola price discovery. Efficiency gains as a consequence of increased competition and depressed prices for vegetable oils in the mid 1980's, would be consistent with the Geweke test results of the relationship between A.W.P. canola street prices and rapeseed futures contract prices demonstrating a more rapid price adjustment mechanism.

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[32] The 1985 study by Veeman and Moreau performed tests on data for the time period from 1979 to 1983.

Linkages Between Chicago Board of Trade Soybean and Product Futures Prices and the A.W.P. Canola Street Prices

The following discussion involves analysis of the results from the Geweke tests for lead-lag relationships between the futures prices for soybeans, and products, and A.W.P. street prices for canola seed. The results from tests conducted on this price relationship are given in Tables IV.5 to IV.16 and A.5 to A.28. These results demonstrate four distinct trends, all of which seem to point towards increasing interdependence between the two price series analysed.

The first trend observed is the decreasing number of significant Geweke tests for one-way causality between C.B.O.T. soybean, and products, futures prices, and canola street prices. F-statistics for equations tested on 1983 data demonstrate eighteen significant one-way lead-lag relationships; the direction all of the significant relationships run from futures prices to street prices. Only two significant one-way relationships result from tests using 1986 prices.

The second observation which can be made concerning the results obtained in tests on the lead-lag structure between A.W.P. canola street prices and C.B.O.T. futures contract prices for soybeans and products, is the significance of all of the Geweke tests for regressions including the instantaneous component. This observation suggests that the addition of same-day values for C.B.O.T. soybean, and products, futures contract prices, and A.W.P. canola street prices, add significant explanatory power to Geweke expressions predicting current values of the two price series. Although it is impossible to make inferences with any level of statistical significance from an analysis of the coefficients of determination calculated in this study there are two interesting trends in the R^2 which should be discussed.

The coefficient of determination for the estimated equations that test for one-way causal structure of soybean, oil and meal futures prices on A.W.P. canola street prices decreased over the time period studied. As with canola futures prices, this suggests that the ability of the lagged values of soybean, soyoil and soymeal and canola street prices to account for variation in current price levels of canola prices has decreased between 1983 and 1986.

Finally, the R^2 for Geweke equations testing for instantaneous relationships between C.B.O.T. soy-complex futures prices and A.W.P. canola street prices decreased over the four year period for all relationships tested. The mean value of R^2 for the tests of price relationships between soybean futures prices and A.W.P. canola street prices did not fall quite as much as the mean values of R^2 for the relationships between A.W.P. canola street prices and soyoil or soymeal futures prices as listed on the Chicago Board of Trade (C.B.O.T.) (Table V.1).

Table V.1 contains the mean values of the R^2 for Geweke tests of instantaneous lead-lag relationships between C.B.O.T. soybean, and products, futures contract prices and A.W.P. canola street prices. In 1983, the mean value of R^2 for equations estimating the contemporaneous lead-lag relationship between the C.B.O.T. soyoil futures contract prices and A.W.P. canola street prices was 34.5 percent and in 1986 this was 29.1 percent. Geweke equations estimating the contemporaneous relationship betwen 1983 C.B.O.T. soybean futures contracts prices and corresponding A.W.P. canola street prices had a mean R^2 of 28.8 percent, with an insignificant drop to 28.7 percent in 1986. Meanwhile, the mean R^2 for Geweke equations estimating the contemporaneous relationship between C.B.O.T. soymeal futures contract prices and A.W.P. canola street prices fell from 32.1 percent in 1983 to 15.9 percent in 1986.

Mean levels of the overall goodness of fit for the estimated Geweke equations testing for instantaneous causality between 1983 and 1986 may be decreasing (see Tavle V.1). However, it is interesting to note that throughout this time period, 99% of regression coefficients representing the instantaneous same-day value for the independent variable are significant. These same-day values are represented by the C.B.O.T. futures contract price for soybeans, or products, when the A.W.P. canola street price is the dependent variable, and by the same-day value for the A.W.P. canola street price, when C.B.O.T. futures contract prices for soybeans and products are the dependent variables. The frequency of the significance of all lagged price variables is decreasing for Geweke tests on both instantaneous and one-way lead-lag relationships between A.W.P. canola street prices and C.B.O.T. soybean, and

product futures prices between 1983 and 1986, but the number of significant same-day price variables remains consistent throughout the period (Tables A.5 to A.28).

There may seem to be a conflict between the second and fourth observations made above, however, these are not mutually exclusive. Coefficients of determination measure the ability of all variables included in the regression to account for variations in the dependent variable. The F-statistics reported here are partial F-statistics that examine the significance of variables added to the original equation (Johnston, 1984). For the purpose of this study, the F-statistics calculated to test for one-way lead-lag relationships are testing the significance of the addition of the lagged independent price variable to Geweke equations estimating the A.W.P. canola street price or the C.B.O.T. futures contract price for soybeans, or products. The F-statistics calculated to observe contemporaneous price relationships test the significance of the addition of the same-day independent price variable. Significant F-statistics from equations testing for contemporaneous correlation mean that the instantaneous component adds significant explanatory power to the equation. While the ability of the regression coefficients to account for variation in the dependent variable may be decreasing, the addition of the variable representing the same-day price level of the independent variable can still add significant explanatory power to the Geweke equation. These results would seem to suggest that although the statistical interdependence between price determination of C.B.O.T. soybean, and product, futures prices and A.W.P. canola street prices may be decreasing, there is still a significant instantaneous lead-lag relationship between them during the time period studied.

Test results from Geweke equations estimating lead-lag relationships between A.W.P. canola street prices, and C.B.O.T. futures contract prices for soybeans, and products, suggested interdependent price formation between the two markets. There appear to be several important features during the time period from 1983 to 1986 which may have affected the results of this section of the study and should be examined. These are changes in Crow rate effects; interest rate effects; and the effects of canola achieving the "Generally Regarded as Safe Standard" (GRAS) designation from the U.S. Food and Drug Administration.

Changes in the Crow rate for western Canadian grain transportation were previously discussed with reference to possible effects on lead-lag relationships between W.C.E. rapeseed futures prices and A.W.P. canola street prices. Influences on lead-lag relationships between C.B.O.T. soybean, and products futures contract prices and canola cash prices would be very similar to those previously mentioned; a removal of distortions within the Canadian transportation system would be expected to enable more rapid adjustment between American oilseed futures prices and Canadian canola cash prices (Fama, 1970).

The possibility of exchange rate effects on price determination in related markets should be addressed in a discussion of relationships between American and Canadian oilseed prices. This report analyses relationships between price levels in the two oilseed markets, expressed in national currency over a four year period. Small changes in exchange rates may affect Canadian street prices for canola, and could be one of many contributing factors to the variability of farm-level prices. Highly volatile exchange rates could obscure lead-lag test results by dampening, or exaggerating, the price adjustment between Canadian canola and American futures contract prices for soybeans and products. The variability of exchange rates between Canadian and American currencies, for the years from 1982 to 1986, is examined in order to assess whether lead-lag test results between A.W.P. canola street prices and C.B.O.T. futures prices for soybeans, and products might have been affected by this influence.[33]

Annual tests of homogeneity of variances (Bartlett's tests) were performed on average monthly closing spot rates of the U.S. dollar per Canadian dollar, from January 1982 to December 1986.[34] The results from these tests, given in Table V.3, demonstrated rejection of

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[33] Although the lead-lag analysis only includes futures contracts from the period including 1983 to 1986, 1983 contracts are sold beginning early in 1982 and thus an analysis of exchange rates must include 1982 values due to their possible affects on relationships between 1983 soybeans, and products prices, and the corresponding canola street price.

[34] Bartlett's test generates a likelihood ratio test statistic for testing the null hypothesis of $\sigma_1^2 = \sigma_1^2 = \ldots = \sigma_m^2$, which is

$$M = \frac{(T-M)\ln\delta^2 \; - \; \Sigma^m_{i=1}(Ti-1)\;\ln\delta_i^2}{1 \; + \; [1/3\;(m-1)]\;[\Sigma^m_{i=1}\;1/(Ti-1) \; - \; 1/(T-m)]}$$

where T is the total number of observations and m is the number of sub-samples:

the null hypothesis of constant variance of mean exchange rate values at a 5 percent level of significance. This does suggests the possibility of influences on lead-lag relationships between Canadian and American oilseeds prices due to differences in variability in exchange rates over time.

A second Bartlett's test was performed to compare only 1982 and 1986 mean exchange rate values. Results from this test demonstrated a significant difference at the 5 percent level between the variance of the two series. Table V.3 demonstrates that the value of the mean variance for the 1982 series is greater than the mean variance of the 1986 series. In fact, the variance of average monthly closing spot rates of the U.S-Canadian currency exchange rate, calculated for 1986 data, is the second lowest for the period from 1982 to 1986 (Table V.3). A Bartlett's test comparing the 1983 mean exchange rate variance and the 1986 mean exchange rate variance rejected the null hypothesis of homogeneity between the two figures at the 5 percent level. Values for the variances of mean monthly closing spot exchange rates in Table V.3 demonstrated that the variance of 1986 mean exchange rate values was larger than the variance of 1983 mean exchange rate values. Results of these tests appear to suggest that the extent of exchange rate variability has changed within the time period from 1982 to 1986, as the variance of mean monthly closing spot exchange rates for 1986 was significantly smaller than in 1982, and yet significantly larger than in 1983. The variability of exchange rates may be one factor in canola price volatility; however, the apparent lack of consistently increasing or decreasing trend in exchange rate variability over the time period studied would seem to suggest that this would not consistently affect the lead-lag analysis. The trend towards increasing price interdependency between Chicago futures prices for soybeans, soyoil and soymeal with A.W.P. street prices for canola may be occurring in spite of exchange rate influences, not as a result of them.

A final change in the structure of the canola market which may have influenced the lead-lag relationship between A.W.P. canola street prices and C.B.O.T. futures contract prices for soybeans, and products, may be due to the U.S. Food and Drug Administration

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[34](cont'd) in the example discussed above T=60 and m=5. This M-statistic is approximately distributed χ^2 (m-1), (Judge, *et al.*, 1980).

Table V.3

Mean and Variance of Average Monthly Closing Spot Rates of the U.S.-Canadian Currency Exchange Rate
(Canadian dollars per U.S. dollar)

Year	Mean	Variance
1982	.809	0.00020
1983	.811	0.00001
1984	.772	0.00030
1985	.731	0.00010
1986	.719	0.00007

Source: Calculated from figures reported in Bank of Canada, *Bank of Canada Review*. Public Information Division, Ottawa, various issues.

(FDA) granting canola the status of "generally regarded as safe (GRAS)" in 1985. This change in legislation means that canola oil can now be sold for human consumption in the United States. Since this decision, the Canadian Canola Council has been actively involved in attempting to promote the sale of canola in the cooking and salad oil market in the U.S., more specifically, in the San Francisco region. From October 1985 to May 1986 the United States imported 15,731 metric tonnes of canola oil, which represented a 231 percent increase over imports during the same period in the previous year (U.S.D.A., 1986).

Increasing exports of canola oil to the U.S. have been accompanied by corresponding increases in canola meal exports. In 1986 Canada exported 110 thousand tonnes of canola meal to the U.S., representing a 633 percent increase in Canadian canola meal imports in a little over six years (U.S.D.A., 1986). The granting of GRAS status to canola oil in 1985 and the subsequent increase in oil exports to the United States may have influenced American canola meal imports. However, the combination of changes in the statutory rail rates, efforts to promote exports into U.S. markets, and the favourable exchange rate between Canada and the U.S. (which makes Canadian products relatively cheaper) may also have been influential in

the large increase in Canadian canola meal exports to the U.S. in 1986.[33]

The results of the Geweke tests on lead-lag relationships between the AWP street price for canola and the C.B.O.T. futures contract prices for soybeans and products, seem to suggest increasing interdependence in price formation for the two oilseeds between 1983 and 1986. Rapid adjustment in price determination for the two oilseeds could be a result of an improvement in information available to market participants (Fama, 1970). Increased competitive pressure in the world oilseeds market, combined with the introduction of subsidized freight rates for Canadian canola products, and the introduction of G.R.A.S. status for canola oil are also factors which may have increased interaction between Canadian and American oilseed markets.

[33] It should be noted that an anonymous marketing representative from Alberta Food Products in Fort Saskatchewan, Alberta felt that initial increases in meal exports may have been positively influenced by a slight discount in canola meal prices offered by Canadian crushers.

VI. Summary, Conclusions, and Suggestions for Further Study

A. Summary

The primary objective of this study was to analyse and provide information about lead-lag relationships between Winnipeg Commodity Exchange (W.C.E.) rapeseed futures contract prices, futures prices for soybean, and products, from the Chicago Board of Trade (C.B.O.T.) and Alberta Wheat Pool (A.W.P.) cash prices for canola in the period from 1983 to 1986. The thesis provides a background discussion of the history of canola in Canada followed by a discussion of the development of causality theory by Wiener and Granger. Reference was made to various previous studies observing lead-lag relationships, as well as to one study (Geweke, Meese and Dent, 1983) which compared eight different tests used in the identification of Granger causality. These studies were reviewed in order to determine the appropriate econometric technique to be used in this analysis. The Geweke approach, which utilizes ordinary least squares as the method of testing for temporal structure, was found to be the most acceptable method.

First differenced daily A.W.P. street prices, W.C.E. rapeseed futures contract prices, and C.B.O.T. futures contract prices of soybeans, and products, were analysed in the Geweke framework of testing for temporal structure. Results were discussed in two stages. The first set of results are from Geweke tests on the lead-lag structure between A.W.P. canola street prices and W.C.E. rapeseed futures contract prices. The second results are from Geweke tests on the lead-lag relationships between A.W.P. canola street prices and C.B.O.T. futures contract prices for soybeans and products.

Results from tests of the lead-lag relationship between canola street prices and rapeseed futures contract prices demonstrate four interesting features. The first two features are associated with the decrease in the value of the coefficient of determination and the number of significant F-statistics for equations testing for one way causal structure between 1983 and 1986. This suggests that previous values of rapeseed futures contract prices explain less of the variation in canola price levels in 1986 than in 1983. Two related features of

observations are the increasing values of coefficients of determination from equations testing for instantaneous causal structure, and the significance of all the F-statistics for these tests. The significant instantaneous relationships suggest that information is being disseminated and transmitted between the rapeseed futures and canola cash markets within the space of one trading day. In general the results seem to suggest the development of a closer relationship in the price discovery process between the two markets in the more recent years of the time period studied.

Interesting changes were also evident in the results of the tests for lead-lag relationships between A.W.P. canola street prices and C.B.O.T. futures contract prices between 1983 and 1986. There was a drop in the number of significant F-statistics measuring the overall significance of Geweke regressions testing for one-way causal structure. This was accompanied by a decrease in the mean values of the coefficients of determination from tests of one-way causal structure between soybean, oil and meal futures contract prices, and canola stree prices. The results seem to indicate that the ability of past values of soybean, oil and meal futures contract prices, and canola street prices to predict current values of these same price series is diminishing over the time period studied.

Although it is impossible to generate inferences concerning the signifance of the variations in these coefficients of determination it is interesting to note that the mean levels of the coefficients of determination for Geweke expressions testing for instantaneous lead-lag relationships betwen the soy-complex and A.W.P. canola street prices also fell between 1983 to 1986. The highest mean level of R^2 is that between soyoil futures contract prices and canola street prices, suggesting that these two prices series have a higher correlation than either A.W.P. canola street prices and soybean futures prices, or A.W.P. canola street prices and soymeal futures prices. Although falling from 34.5 percent in 1983, the mean value of R^2 for Geweke regressions testing for instantaneous causality between soyoil futures prices and canola street prices is 29.1 percent in 1986 (Table VI.1). Regressions including past values of these two price series and the present value of the independent variable price series, accounted on average for 29.1 percent of the variation in the dependent variable price series in 1986.

The mean value of R^2 from Geweke equations testing for instantaneous lead-lag relationships between C.B.O.T. soybean futures contract prices and A.W.P. canola street prices dropped by one tenth of a percent between 1983 to 1986 (Table VI.1). The significant F-statistics for the Geweke tests of instantaneous causality combined with the relatively constant mean value of the coefficients of determination seem to suggest that there is a close relationship between price determination of the C.B.O.T. soybean futures contracts and A.W.P. canola prices.

Finally, F-statistics testing instantaneous causality between C.B.O.T. soymeal futures prices and A.W.P. canola street prices are all significant for the time period from 1983 to 1986. However, the mean values of the R^2 from these equations drops from 32.1 percent in 1983 to 15.9 percent in 1986. This drop in the mean value of the R^2 between 1983 and 1986 suggests that the relationship between soymeal futures contract price determination and canola street price establishment, although still significant, may be decreasing.

B. Conclusions

The conclusions of this thesis will be discussed with reference to the four hypotheses of the study listed in Chapter one. The first hypothesis was that W.C.E. futures contract price establishment leads A.W.P. canola street price establishment over the time period studied. The results from Geweke tests in which past values of 1983 W.C.E. futures contract prices and corresponding A.W.P. canola street prices are used to estimate present values of A.W.P. canola street prices seem to support the hypothesis. All five Geweke equations testing for one-way causal structure running from rapeseed futures prices to canola street prices are significant. There are no significant lead-lag relationships running from canola street prices to 1983 rapeseed futures contract prices. For the 1984 data there were four significant one-way relationships running from futures prices to street prices, and one running the opposite direction. Only two significant F-statistics are evident for Geweke equations testing for one-way causal structure running from 1985 rapeseed futures contract prices to canola street prices with one significant relationship running in the opposite direction. Geweke testing of

one-way lead-lag relationships between 1986 rapeseed contract prices and corresponding canola street prices demonstrate only two significant equations, one running from futures price to street price establishment and one running in the opposite direction. The results suggest that the ability of lagged values of rapeseed futures contract prices and canola street prices to predict current cash prices for canola is decreasing over the time period studied. Although supported for results from 1983 and 1984 data, the first hypothesis is rejected for tests on 1985 and 1986 data.

A discussion of the conclusions concerning the second hypothesis may provide insight on the results reported above. The second hypothesis is that the time lag observed between W.C.E. futures price establishment and A.W.P. canola street price formation is diminishing between 1983 and 1986. The significance of all of the Geweke equations testing for instantaneous lead-lag stgructure between W.C.E. rapeseed futures contracts and A.W.P. canola street prices, combined with increasing values of the R^2 from these relationships suggest a close relationship in the price establishment of the two price series. Results from the tests suggest that both rapeseed futures contract prices and A.W.P. canola cash prices respond to changes in each other's price within one lagged time period, that is within one day.

Evidence of a decreasing number of one-way lead-lag relationships between rapeseed futures prices and canola street prices, combined with the increasing mean value of the R^2 for instantaneous lead-lag relationships between these two variables, seems to substantiate the hypothesis of a closely related price determination process. It would appear that factors like the increased maturity and liquidity of the W.C.E. rapeseed futures market may have diminished the time lag between rapeseed futures price establishment and A.W.P. canola street price determination in the time period studied. These test results seem to indicate that the second hypothesis should not be rejected.

The third hypothesis is that C.B.O.T. soybean and products futures contract price establishment leads A.W.P. canola street price establishment between 1983 and 1986. A review of the F-statistics for one-way lead-lag relationships between the various price series for the years from 1983 to 1986 suggests that the third hypothesis should be rejected (Tables III.5 to

III.16). All but 5 out of 23 F-statistics testing one-way lead-lag relationships for soybean, and products futures prices leading canola street prices are significant for 1983 data, while tests on 1986 data produced only 2 out of 23 significant F-statistics for this relationship. These figures emphasize the decline in importance of lagged values of soybean, oil and meal futures contract prices in the price discovery process of A.W.P. canola.

Although test results demonstrated a decline in the ability of lagged values of soybean and products future prices to explain variation in canola street prices, the F-statistics for tests of instantaneous causal structure between the price series were significant throughout the time period studied. This suggests that the four price series have similar reactions to various shocks in the oilseeds market and, more importantly, that the adjustments occur within one trading day. The C.B.O.T. soybeans and products futures contract price establishment does not lead the A.W.P. canola street price establishment and, in fact, the price determination of the series seems to occur simultaneously. Thus hypothesis number three must be rejected.

The final hypothesis of this thesis is that the price determination process for soyoil futures is more closely related to canola cash price determination than is price establishment for soymeal or soybeans. Although not explicitly testable using the Geweke approach the results summarized in Table V.1 seem to substantiate this hypothesis. Mean values of the R^2 from Geweke equations testing for instantaneous lead-lag relationships between 1986 soybean, soyoil and soymeal futures prices, and corresponding canola street prices were 28.7 percent, 29.1 percent and 15.9 percent, respectively. These figures suggest that canola street price determination is more closely related to soyoil futures price establishment than to variations in the futures price of soybeans or soymeal. Hypothesis number four is tentatively not rejected. Further investigation using multivariate models is required to properly test this hypothesis.

Throughout the four year period studied, the mean value of the R^2 from equations testing for instantaneous causal structure between soybeans and canola street prices remained fairly constant. This is consistent with the importance of American soybeans in the world oilseed market. Despite large increases in Malaysian and Indonesian palm oil production and in E.E.C. rapeseed production, the price relationship between American soybean and soyoil

futures prices and Canadian canola street prices remained relatively stable between 1983 and 1986. A drop in mean values of R^2 from equations testing for instantaneous lead-lag relationships between 1983 and 1986 soymeal futures prices, and canola street prices may be a result of the recognition of basic concepts by market participants. Soybean product prices are driven more by meal prices due to the large meal component in soybean crushing. Canola prices are driven more by vegetable oil prices due to the large oil component from canola crushing. Part of the drop in the mean value of R^2 for the equations testing for contemporaneous relationships between soymeal futures prices and canola street prices may have resulted from large surpluses in vegetable oil stocks in the mid-1980's. Large world carry-over stocks of vegetable oil should have a more significant impact on canola prices than on soymeal prices. This may have been a factor in the decreasing importance of soymeal futures prices in canola street price determination between 1985 and 1986.

F-statistics for equations estimating instantaneous lead-lag relationships between the soy-complex futures prices and canola street prices, demonstrate that all three contracts have a significant relationship with canola street price determination in the time period studied. Canola oil now competes directly with U.S. soyoil for American vegetable oil market power due to changes in the G.R.A.S. standards in the spring of 1985. Changes in Canadian rail rate subsidies enacted in January of 1984 may be a factor in the increased canola oil and meal exports into the U.S. between 1983 and 1986. The Canadian Canada Council's efforts at expanding canola product exports combined with the proximity of the Canadian and American markets may also have been contributed to the continued significant relationship between soybean, oil and meal futures price establishment and canola street price discovery.

Regardless of the reasons, the results of this analysis suggested that there was a high degree of interdependence within price formation between futures prices of W.C.E. rapeseed contracts, C.B.O.T. soybean, oil and meal contracts, and A.W.P. canola street prices, between 1983 and 1986. It should be restated that the Geweke models tested here only demonstrate past statistical associations between variables. Despite this limitation, the preceeding analysis provided empirical tests of hypotheses which previously had been untested.

C. Suggested Areas For Further Study

One of the weaknesses of the Geweke (O.L.S.) analysis is the limitation of the number of variables which can be analysed within the estimation procedure. This analysis demonstrated the statistical time ordered relationship between various futures contract prices to the A.W.P. cash price for canola. As was mentioned in the body of the thesis, there are other demand and supply factors in the world oilseed market which may have significant effects on price determination of Canadian canola. The results of a behavioural model including variables to represent these factors would be of interest to those involved in the canola industry.

Such a model would include variables accounting for Indonesian and Malaysian palm oil acreage and production; E.E.C. rapeseed and canola acreage and production; American soybean acreage and production; oilseed carry-over, and various influences from both domestic and foreign policy that occur from year to year and may affect price discovery. For canola, a system of equations such as outlined above could be estimated using a procedure like Vector Autoregression (V.A.R.). The V.A.R. procedure combines the time series nature of ARIMA models and the structural nature of a Geweke system (Adamowicz, 1985). Information provided by such a model could provide additional valuable information to the Canadian canola industry.

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Appendix A: Tables Presenting Regression Results

The tables listed in Appendix A present the coeffficients and coefficients of determination from all Geweke equations analysed in this study. The significance of coefficients representing both lagged and same-day prices from the various series is indicated at a 5 percent level. Results from the four years of analysis of the time ordered associated between Alberta Wheat Pool (A.W.P.) canola street prices and Winnipeg Commodity Exchange (W.C.E.) rapeseed futures prices are listed in Tables A.1 to A.4. Tables A.5 to A.12 list the results from Geweke tests of the lead-lag relationship between A.W.P. canola street prices and Chicago Board of Trade (C.B.O.T.) soybean futures prices. Results from tests of causal structure between A.W.P. canola street prices and C.B.O.T. soyoil futures prices are presented in Tables A.13 to A.20. The remaining eight tables (A.21 to A.28) present the results of tests for time ordered association between A.W.P. canola cash prices and C.B.O.T. soymeal futures prices.

Table A.1

Regression Results from Bivariate Causality Tests on 1983 Rapeseed Futures Contracts and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.792	•-.603	•-.404	•-.258	•-.131		•1.110	•.487	-.160	.257	.020	39.6
Jan→Str	•-.789	•-.567	•-.379	•-.227	-.109	•.890	•.971	•.549	-.147	.215	.034	44.9
Mar→Str	•-.765	•-.965	•-.385	•-.261	•-.140		•1.100	•.481	-.293	.457	.113	39.2
Mar→Str	•-.764	•-.542	•-.374	•-.240	•-.122	•.833	•.970	.485	-.166	.366	.086	43.6
June→Str	•-.774	•-.589	•-.423	•-.279	•-.151		•.959	•.412	-.175	.336	.034	39.0
June→Str	•-.774	•-.570	•-.410	•-.261	-.133	•.742	•.916	•.443	-.048	.299	.013	42.4
Sept→Str	•-.809	•-.625	•-.445	•-.230	•-.149		•1.070	•.441	.228	.152	.038	37.1
Sept→Str	•-.806	•-.582	•-.413	•-.266	-.128	•.927	•.964	•.408	.122	.178	.073	48.2
Nov→Str	•-.775	•-.588	•-.409	•-.261	•-.134		•.907	•.539	.190	.137	.004	33.0
Nov→Str	•-.771	•-.550	•-.383	•-.237	-.114	•.937	•.857	•.498	.215	.186	.098	48.3
Str→Jan	•.192	-.069	-.015	.046	-.016		-.004	-.040	-.028	-.035	-.024	4.9
Str→Jan	.044	-.117	.001	.022	-.017	•.098	•.074	.019	.012	-.010	-.011	13.1
Str→Mar	•.157	-.005	•-.153	.109	.031		-.002	-.028	-.014	-.025	-.022	6.6
Str→Mar	.061	-.047	•-.128	.069	.022	•.087	•.065	.021	.020	-.003	-.009	13.4
Str→June	.059	-.041	•-.171	.049	.029		0	-.026	-.017	-.025	-.025	6.0
Str→June	-.013	-.073	•-.158	.024	.026	•.075	•.058	.018	.014	-.004	-.013	11.2
Str→Sept	.120	.035	.114	-.028	-.038		-.003	-.047	-.034	-.037	-.024	3.3
Str→Sept	-.084	-.048	.071	-.057	-.045	•.189	•.150	•.071	.050	.028	.004	20.2
Str→Nov	.052	.044	-.027	-.051	-.100		-.004	-.041	-.029	-.025	-.021	3.3
Str→Nov	•-.167	-.087	-.073	-.085	-.101	•.243	•.184	•.102	.071	.038	.011	25.2

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.2

Regression Results from Bivariate Causality Tests on 1984 Rapeseed Futures Contracts and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	*-.625	*-.368	*-.231	-.144	-.100		*.644	*.425	.078	.087	.013	18.3
Jan→Str	*-.611	*-.371	*-.234	*-.145	-.077	*.906	*.584	*.438	.138	.110	.062	60.8
Mar→Str	*-.712	*-.578	*-.423	*-.297	*-.184		*.557	*.427	*.311	*.267	.094	30.3
Mar→Str	*-.764	*-.615	*-.452	*-.302	*-.174	*.615	*.710	*.531	*.408	*.307	.129	45.6
June→Str	*-.304	*-.130	-.021	.009	.002		-.000	-.000	-.000	-.000	-.000	8.6
June→Str	*-.306	*-.139	-.020	.024	.006	0.000	0.000	0.000	0.000	0.000	0.000	9.1
Sept→Str	*-.408	*-.144	-.007	.095	*.128		*.819	.016	.156	-.879	-.253	15.3
Sept→Str	*-.428	*-.169	-.019	.075	.084	*1.100	*.615	.089	.107	-.051	-.093	36.5
Nov→Str	*-.352	-.092	.023	.082	*.109		*.676	.048	.144	.046	-.230	12.1
Nov→Str	*-.330	-.088	.021	.074	*.100	*1.050	*.520	.155	.151	.067	-.113	30.0
Str→Jan	.066	-.014	-.066	-.025	-.053		-.015	.003	.003	.001	-.025	1.5
Str→Jan	*-.303	*-.258	-.111	-.075	-.061	*.573	*.344	*.215	*.135	.083	.032	52.7
Str→Mar	*-.248	*-.168	*-.158	-.065	-.057		.085	.061	.048	.007	-.015	6.1
Str→Mar	*-.448	*-.321	*-.269	*-.161	-.091	*.358	*.339	*.267	*.199	.113	.050	26.8
Str→June	*-.840	*-.656	*-.487	*-.315	*-.156		-72.300	*-316.400	33.100	*524.800	129.700	44.6
Str→June	*-.841	*-.656	*-.488	*-.315	*-.157	-206.700	-135.100	*-343.300	28.900	*526.700	130.100	44.9
Str→Sept	*.186	-.067	.045	-.034	*-.146		.018	.023	.011	.018	.040	6.2
Str→Sept	-.001	-.070	.009	-.014	-.088	*.228	*.111	*.056	.126	-.002	.011	29.7
Str→Nov	*.149	-.103	-.007	-.020	*-.111		-.021	-.003	.002	.008	.008	4.0
Str→Nov	.017	*-.112	-.035	-.029	-.066	*.195	*.047	.014	-.002	-.008	-.013	23.7

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.3

Regression Results from Bivariate Causality Tests on 1985 Rapeseed Futures Contracts and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•.180	-.046	•.150	.026	•.285		•218	.116	-.027	.012	•-.328	18.4
Jan→Str	•.268	-.006	•.089	.035	•.230	•.963	-.015	•.143	.025	-.017	•-.212	56.3
Mar→Str	•.265	.001	.085	.051	•.180		.031	.033	.025	-.048	-.069	16.2
Mar→Str	•.171	.008	.095	.061	•.172	•.267	•.187	•.128	.078	-.021	-.057	28.8
June→Str	•.248	-.026	.056	-.024	•.332		.088	-.033	.079	-.158	•-.441	18.9
June→Str	•.307	.031	•.123	-.043	•.280	•1.020	•-.147	-.025	-.018	-.087	-.118	64.9
Sept→Str	•-.233	-.070	-.077	•.174	-.011		•.303	.102	.090	•-.266	-.142	6.2
Sept→Str	•-.250	-.050	-.076	•.193	.069	•.969	•.343	.081	.011	•-.255	•-.233	57.0
Nov→Str	-.064	-.077	.018	.058	-.064		.080	•.181	-.120	-.052	-.102	5.7
Nov→Str	•-.172	•-.151	-.019	.060	-.046	•.654	•.319	•.300	-.016	-.044	•-.130	37.3
Str→Jan	•.242	-.028	-.054	.031	-.121		-.091	-.041	.064	-.009	.057	5.2
Str→Jan	•.137	-.084	-.041	.025	.037	•.482	•-.178	-.019	-.009	-.022	•-.080	49.2
Str→Mar	•-.587	•-.357	•-.198	-.104	-.047		•.355	-.026	-.034	-.036	.032	23.5
Str→Mar	•-.604	•-.376	•-.213	-.077	-.008	•.562	•.206	-.026	-.082	-.064	-.070	35.0
Str→June	•.230	-.008	.095	-.070	•-.316		-.058	-.566	-.066	.019	.051	13.8
Str→June	•.181	.011	.051	.018	-.071	•.556	•-.196	-.041	•-.097	.032	•-.133	62.8
Str→Sept	-.042	.022	.081	-.011	.094		.017	-.021	-.001	-.020	-.083	1.3
Str→Sept	•-.211	-.035	.031	•.137	•.173	•.559	•.147	.018	.042	•-.117	-.077	54.8
Str→Nov	•-.365	•-.182	•-.159	-.011	.043		•.166	.113	.056	-.001	-.028	8.9
Str→Nov	•-.406	•-.275	-.097	.153	.954	•.512	•.198	•.152	.046	-.031	.005	39.5

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A:4

Regression Results from Bivariate Causality Tests on 1986 Rapeseed Futures Contracts and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→[2]Str	•-.163	-.005	-.021	.042	•-.139		•.265	.016	-.052	-.060	.101	3.7
Jan→Str	•-.122	-.013	•-.106	.028	•-.103	•1.010	•.301	.078	.047	.023	.015	62.8
Mar→Str	•-.207	-.040	-.095	-.003	•-.168		•.337	.065	.078	.050	.0150	5.1
Mar→Str	•-.118	-.022	•-.112	.047	•-.162	•.108	•.221	.096	.090	.021	.118	55.5
June→Str	•-.306	-.074	-.052	.009	•-.191		•.428	.009	-.028	-.009	.188	7.8
June→Str	•-.230	-.059	•-.115	.039	•-.183	•.105	•.307	•.137	.114	.010	•.163	64.6
Sept→Str	•.224	-.127	-.123	.042	.116		•-.200	.023	.057	-.127	-.089	5.4
Sept→Str	•-.214	•-.192	-.109	-.043	.061	•.858	•.224	•.200	.096	.011	-.017	69.5
Nov→Str	.134	•-.328	-.078	-.071	-.003		-.045	.229	.016	0.000	-.026	5.0
Nov→Str	.031	•-.184	-.061	-.054	-.034	•1.010	-.023	•.213	.010	.067	.039	81.7
Str→Jan	-.036	-.061	-.098	-.082	.085		-.040	.008	.083	.014	-.035	2.5
Str→Jan	•-.170	-.069	.072	-.052	.034	•.504	.042	.010	•.094	-.007	.035	52.3
Str→Mar	.107	-.028	-.011	.027	.030		-.082	-.016	.015	-.046	-.005	1.3
Str→Mar	-.059	-.060	-.049	.002	-.044	•.491	.019	.003	.062	-.045	•.077	53.8
Str→June	.115	-.012	-.135	-.019	.024		-.073	-.014	.060	-.028	-.007	3.8
Str→June	•-.136	•-.127	•-.119	-.013	-.086	•.586	•.107	.030	•.091	-.034	•.105	63.1
Str→Sept	•-.494	•-.207	-.045	-.161	-.084		•.510	.075	-.017	.099	.065	11.4
Str→Sept	•-.336	•-.224	-.090	-.061	-.013	•.790	•.333	•.176	.081	.066	-.027	71.5
Str→Nov	-.022	.016	.006	-.066	-.063		.102	-.143	-.017	-.017	.031	3.8
Str→Nov	.014	•-.167	-.007	-.066	-.043	•.797	-.005	•.119	.045	.040	.033	81.4

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.5

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1983 Soybean Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	*-.688	*-.509	*-.374	*-.234	*-.110	*-.264	.091	.064	.046	-.036	31.6
Mar→Str	*-.693	*-.516	*-.379	-.238	*-.116	*.274	.089	.068	.038	-.033	31.8
May→Str	*-.667	*-.482	*-.351	*-.208	*-.096	*.211	.073	.065	.017	-.033	30.1
July→Str	*-.651	*-.468	*-.338	*-.200	*-.095	*.189	.097	.069	.033	-.026	28.8
Aug→Str	*-.659	*-.485	*-.352	*-.210	*-.099	*.185	*.141	.085	.034	.006	29.0
Sept→Str	*-.620	*-.440	*-.305	*-.171	-.086	*.205	*.131	.072	.008	.003	25.7
Nov→Str	*-.592	*-.395	*-.284	*-.153	-.074	*.164	*.102	*.086	-.011	-.022	24.8
Str→Jan	-.052	.065	.069	-.030	-.088	.026	-.011	.015	.015	.014	2.0
Str→Mar	-.032	.047	.077	-.042	-.091	.036	-.009	.018	.019	.022	2.1
Str→May	-.023	.022	.088	-.007	-.074	.029	-.003	.020	.018	.021	1.6
Str→July	-.041	.016	.048	-.007	-.057	.033	-.011	.010	.029	.032	1.0
Str→Aug	.077	*.112	.036	.001	-.029	.019	-.036	.021	.049	.045	2.7
Str→Sept	*.123	.024	.006	-.096	-.054	-.017	-.102	-.075	-.055	-.049	4.0
Str→Nov	.097	-.004	.031	*-.120	*-.113	-.073	*-.157	-.145	-.111	-.081	7.0

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.6

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1983 Soybean Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	*-.697	*-.505	*-.379	*-.239	*-.115	*.341	*.282	.069	.040	.056	-.006	36.2
Mar→Str	*-.705	*-.513	*-.386	*-.245	*-.119	*.349	*.286	.073	.041	.053	-.001	36.7
May→Str	*-.677	*-.482	*-.357	*-.214	*-.102	*.298	*.218	.067	.039	.019	-.011	34.6
July→Str	*-.661	*-.465	*-.341	*-.209	*-.104	*.294	*.201	.092	.055	.035	-.010	34.0
Aug→Str	*-.664	*-.475	*-.358	*-.224	*-.111	*.280	*.164	*.109	.075	.034	.014	35.1
Sept→Str	*-.616	*-.414	*-.285	*-.157	-.073	*.256	*.173	*.125	*.078	.016	.011	32.8
Nov→Str	*-.574	*-.357	*-.248	*-.126	-.054	*.244	*.105	*.102	*-.079	-.018	-.005	30.4
Str→Jan	-.010	.047	.057	-.039	-.081	*.198	*.162	.089	.089	.061	.036	8.6
Str→Mar	-.089	.028	.063	-.050	-.084	*.206	*.179	.098	.097	.069	.045	9.2
Str→May	-.069	.006	.075	-.011	-.067	*.217	*.174	*.102	.096	.063	.042	8.0
Str→July	-.089	-.008	.031	-.015	-.051	*.250	*.196	*.106	.095	.079	.056	8.3
Str→Aug	.021	.070	.010	-.010	-.031	*.303	*.219	.111	*.127	.113	.075	10.9
Str→Sept	.047	-.025	-.021	-.093	-.053	*.372	*.214	.061	.039	.008	-.017	13.2
Str→Nov	.023	-.050	-.007	*-.115	*-.103	*.450	*.194	.021	-.017	-.042	-.048	17.2

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.7

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1984 Soybean Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.606	•-.397	•-.287	•-.147	-.060	•.135	•.130	.065	.019	.020	26.0
Mar→Str	•-.526	•-.335	•-.181	-.082	-.061	•.142	.040	-.025	-.019	-.019	20.5
May→Str	•-.471	•-.255	•-.149	-.072	-.037	•.143	.012	.069	.019	-.019	17.1
July→Str	•-.371	•-.162	-.055	-.013	.003	•.158	.037	.046	.045	-.008	10.9
Aug→Str	•-.277	-.080	.001	.027	.044	•.148	.031	.049	.035	-.019	7.0
Sept→Str	•-.265	-.060	.013	.053	.049	•.167	.018	.074	.023	-.024	7.1
Nov→Str	•-.245	-.058	.035	.065	.061	•.137	.040	.039	-.004	-.053	6.0
Str→Jan	.075	.039	.017	-.101	-.075	-.093	-.103	-.135	-.086	-.083	4.1
Str→Mar	.096	.025	-.001	-.014	-.011	-.131	-.126	-.112	-.111	-.103	2.5
Str→May	.078	-.032	.048	•-.124	-.063	-.066	.008	-.048	-.044	-.074	3.8
Str→July	.063	-.032	-.032	-.059	-.055	-.041	.057	.043	.005	-.066	1.9
Str→Aug	.040	.026	-.024	-.069	-.029	-.028	.023	-.006	-.031	-.086	1.8
Str→Sept	-.048	-.043	-.076	•-.154	-.052	-.033	.028	.004	.019	-.049	3.7
Str→Nov	-.059	-.014	•-.115	-.088	-.071	-.048	-.014	-.011	-.014	-.038	3.6

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.8

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1984 Soybean Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.587	•-.375	•-.259	•-.129	-.043	•.209	•.119	•.122	.061	.040	-.004	32.4
Mar→Str	•-.491	•-.301	•-.151	-.052	-.034	•.268	•.116	.033	-.024	-.015	-.016	31.5
May→Str	•-.452	•-.257	•-.135	-.059	-.015	•.284	•.121	.021	.055	.055	-.001	29.1
July→Str	•-.358	•-.180	-.069	-.014	.024	•.327	•.138	.048	.057	.064	.010	26.9
Aug→Str	•-.267	-.088	.002	.038	.074	•.344	•.134	.022	.057	.059	-.009	22.6
Sept→Str	•-.252	-.070	.011	.046	.068	•.379	•.185	.034	•.102	.082	-.005	20.5
Nov→Str	•-.227	-.053	.039	.070	.074	•.365	•.158	.045	.081	.028	-.028	16.5
Str→Jan	.019	.015	-.009	•-.109	-.066	•.411	.156	.060	-.017	-.026	-.059	12.3
Str→Mar	.023	.004	.011	-.004	-.001	•.516	.140	.047	-.018	-.068	-.071	16.0
Str→May	.005	-.038	.013	•-.133	-.054	•.504	•.171	•.137	.027	-.007	-.055	17.7
Str→July	-.024	-.052	-.058	-.084	-.051	•.547	•.162	•.145	.073	.012	-.067	19.5
Str→Aug	-.032	.011	-.048	-.086	-.020	•.485	.106	.062	-.006	-.044	-.107	18.2
Str→Sept	•-.111	-.050	•-.104	•-.163	-.043	•.381	.068	.050	-.007	-.001	-.068	17.6
Str→Nov	-.100	-.026	•-.127	-.087	-.054	•.305	.027	.004	-.022	-.034	-.057	14.3

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.9

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1985 Soybean Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.263	-.058	.047	.085	.078	•.165	.036	.050	.007	-.070	7.4
Mar→Str	•-.265	-.068	.049	•.094	.085	•.203	.009	.074	-.007	-.059	8.8
May→Str	•.247	.012	•.067	.048	.055	.024	-.001	-.004	-.068	.004	9.7
July→Str	•.264	-.053	•.150	-.041	•.163	.016	.005	-.021	-.042	-.023	11.7
Aug→Str	•.271	.004	.045	-.059	.102	.001	•-.083	.041	-.013	-.016	9.9
Sept→Str	.048	.033	-.030	.066	.019	.019	-.053	.028	-.063	-.070	2.2
Nov→Str	.068	.032	-.056	.062	.019	.033	-.059	.067	-.051	-.081	2.9
Str→Jan	-.044	-.017	•-.114	-.050	-.060	-.042	.005	-.007	.005	-.005	2.5
Str→Mar	-.020	-.024	-.076	-.033	-.065	-.042	-.002	-.003	.010	.004	1.5
Str→May	.015	-.022	-.086	-.043	-.079	•-.159	.059	.027	.025	.002	2.7
Str→July	.010	-.042	-.099	-.038	-.077	•-.144	.063	-.002	.017	.023	2.6
Str→Aug	-.042	-.057	-.068	-.019	-.082	•-.255	-.019	-.008	-.060	-.036	5.8
Str→Sept	-.061	-.030	-.003	-.061	-.081	-.131	-.049	.017	-.092	.046	4.1
Str→Nov	-.086	-.006	.021	-.055	.042	-.042	.004	-.011	-.055	-.046	1.9

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.10

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1985 Soybean Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.247	-.060	.049	.083	.080	•.361	•.181	.042	.091	.025	-.049	15.3
Mar→Str	•-.250	-.067	.050	•.091	.083	•.358	•.210	.017	.101	.005	-.036	16.0
May→Str	•.302	-.008	•.057	.039	•.054	•.346	.019	.007	.026	-.053	.031	26.8
July→Str	•.313	-.074	•.150	-.050	•.156	•.337	.012	.020	.012	-.030	.003	28.2
Aug→Str	•.351	.010	.048	-.040	•.113	•.316	.014	•-.065	•.063	-.007	.009	30.6
Sept→Str	.092	.050	-.036	•.097	.003	•.333	.039	-.043	.029	-.043	-.043	18.6
Nov→Str	•.097	.034	-.063	.081	.005	•.336	.047	-.061	.071	-.032	-.066	17.8
Str→Jan	-.083	-.025	•-.125	-.052	-.042	•.236	.020	.019	-.018	-.014	-.023	10.8
Str→Mar	-.064	-.026	•-.092	-.031	-.051	•.221	.017	.013	-.014	-.010	-.014	9.3
Str→May	.002	-.021	-.084	-.007	-.081	•.547	•-.294	.053	.009	-.001	-.028	21.1
Str→July	.001	-.045	-.082	-.015	-.064	•.554	•-.290	.092	-.083	.041	-.068	20.8
Str→Aug	-.043	.004	•-.098	-.009	-.071	•.729	•-.452	-.022	-.041	-.017	-.111	27.5
Str→Sept	-.017	-.004	-.017	-.029	-.046	•.502	•-.154	-.066	.032	•-.125	.037	20.2
Str→Nov	-.057	.031	-.042	-.031	-.008	•.462	•-.118	-.020	.047	.084	.033	17.1

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.11

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1986 Soybean Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	-.062	.005	-.092	.040	•-.104	•.078	-.058	.033	-.017	.033	3.5
Mar→Str	-.062	.008	-.096	.033	•-.127	.053	-.061	.046	.005	.043	3.9
May→Str	-.073	-.040	•-.162	.014	•-.126	.072	-.041	•.082	.025	.030	4.9
July→Str	-.057	-.044	•-.150	-.004	•-.132	•.078	-.030	.062	.034	.021	4.4
Aug→Str	•-.175	-.087	•-.244	.024	-.035	.052	.002	•.124	.014	.002	6.7
Sept→Str	-.110	-.047	•-.203	.062	-.028	.013	-.047	•.100	-.030	-.050	6.3
Nov→Str	-.062	-.061	•-.208	.032	-.070	-.026	-.033	•.119	-.007	-.006	5.5
Str→Jan	-.075	-.053	-.048	-.087	.077	-.010	.081	•.159	.110	-.020	3.2
Str→Mar	•-.111	-.064	-.049	-.047	.061	.010	.080	•.169	.102	-.023	3.0
Str→May	-.077	-.071	-.030	-.038	.053	-.002	.026	.115	.085	-.074	2.2
Str→July	-.066	-.053	-.032	-.055	.070	.031	-.013	.065	.033	-.128	1.6
Str→Aug	-.051	-.070	.088	.006	•.140	-.058	-.033	-.083	-.015	-.098	3.3
Str→Sept	-.059	•-.135	.101	-.060	-.070	.067	-.029	-.064	.074	-.091	4.0
Str→Nov	-.026	-.077	.071	-.058	.020	.044	-.064	-.027	.067	-.093	2.6

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.12

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1986 Soybean Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	-.059	-.022	•-.146	.003	•.097	•.336	•.103	-.040	.048	.012	.007	22.9
Mar→Str	-.065	-.017	•-.151	.001	•-.119	•.320	•.088	-.041	.061	.020	.024	23.7
May→Str	-.072	-.049	•-.202	-.016	•-.100	•.349	•.099	-.016	•.093	.038	.012	26.4
July→Str	-.069	-.039	•-.174	-.016	-.085	•.370	•.103	-.010	•.074	.036	-.005	26.8
Aug→Str	•-.150	-.073	•-.208	.030	.007	•.432	•.074	.034	•.087	.011	-.059	37.7
Sept→Str	•-.138	-.035	•-.177	.032	.010	•.412	.038	.008	.059	-.005	-.079	31.5
Nov→Str	-.081	-.033	•-.197	.003	-.030	•.426	-.015	-.001	.089	.017	-.015	31.6
Str→Jan	•-.122	-.019	-.067	-.077	.057	•.600	.028	.078	•.215	.087	.042	22.7
Str→Mar	•-.145	-.025	-.078	-.050	.033	•.640	.049	.074	•.231	.081	.058	22.9
Str→May	•-.124	-.045	-.083	-.054	.034	•.646	.045	.052	•.219	.077	.008	24.3
Str→July	•-.119	-.033	-.075	-.029	.056	•.684	.070	.017	•.168	.036	-.038	26.5
Str→Aug	-.090	-.072	-.008	-.005	•.138	•.767	.076	.034	.105	-.034	-.071	35.4
Str→Sept	-.068	•-.104	.036	-.041	•.108	•.652	•.139	.001	.068	.033	-.073	29.8
Str→Nov	-.009	-.055	-.006	-.053	.024	•.650	.085	-.025	.108	.047	-.048	29.6

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.13

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1983 Soyoil Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	*-.692	*-.519	*-.382	*-.237	*-.118	*7.380	3.310	2.830	.927	.808	31.9
Mar→Str	*-.677	*-.503	*-.371	*-.227	*-.109	*6.770	*3.540	2.960	1.040	.796	30.9
May→Str	*-.619	*-.426	*-.307	*-.176	.082	-.079	-.040	.089	-.025	-.079	28.2
July→Str	*-.665	*-.488	*-.363	*-.213	*-.102	*6.360	*4.530	2.860	1.530	.640	30.0
Aug→Str	*-.706	*-.555	*-.427	*-.265	*-.128	*5.920	*5.150	3.430	1.250	-.111	32.4
Sept→Str	*-.641	*-.452	*-.322	*-.193	-.099	*6.370	1.850	1.320	-1.070	-.518	27.3
Oct→Str	*-.649	*-.463	*-.337	*-.206	-.097	*5.330	1.780	.818	-.006	-1.110	27.7
Dec→Str	*-.629	*-.432	*-.333	*-.216	*-.121	*4.040	*3.400	1.240	.751	-.841	27.5
Str→Jan	.031	.034	*.135	-.030	-.099	.001	-.001	-.001	-.000	.000	2.8
Str→Mar	-.047	.031	*.131	-.071	*-.105	.001	-.001	.000	.001	.007	3.5
Str→May	*-.051	*-.372	*-.146	*-.124	-.384	-.007	-.012	-.014	-.009	-.003	25.3
Str→July	-.066	-.003	.019	.026	-.080	.001	-.001	-.001	.000	.000	1.5
Str→Aug	.019	*.144	*.203	*.128	.044	-.001	-.003	-.004	-.003	-.001	7.0
Str→Sept	*.203	.078	.073	-.109	-.074	.001	-.001	-.001	-.002	-.002	8.6
Str→Oct	*.224	.039	.087	.011	*-.190	-.001	-.005	-.005	*-.006	-.004	10.9
Str→Dec	*.217	.033	.062	-.053	*-.093	-.001	-.002	-.003	-.005	-.004	8.3

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.14

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1983 Soyoil Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_6	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	*-.693	*-.507	*-.373	*-.233	*-.121	*8.740	*7.650	3.010	1.640	1.190	1.670	35.7
Mar→Str	*-.686	*-.502	*-.371	*-.228	*-.116	*8.260	*7.160	3.280	1.870	1.630	1.660	34.6
May→Str	*-.618	*-.426	*-.307	*-.175	-.082	.049	-.077	-.022	.097	-.019	-.061	28.3
July→Str	*-.673	*-.485	*-.353	*-.209	*-.102	*8.540	*6.920	*4.560	2.700	1.300	1.320	33.7
Aug→Str	*-.705	*-.528	*-.396	*-.243	*-.117	*8.120	*5.770	*3.980	1.780	.203	-.472	37.1
Sept→Str	*-.651	*-.443	*-.313	*-.177	.085	*8.050	*4.730	1.220	.733	-.185	-.079	35.8
Oct→Str	*-.643	*-.427	*-.298	*-.161	-.070	*7.370	*3.670	1.490	.176	-.084	-.294	36.5
Dec→Str	*-.623	*-.420	*-.317	*-.188	-.095	*6.040	*2.730	*3.200	.866	1.070	-.277	33.9
Str→Jan	-.078	.013	*.117	-.035	*-.104	*.006	*.005	.002	.001	.001	.001	8.2
Str→Mar	-.091	.008	*.112	-.078	-.110	*.006	.005	.003	.002	.002	.001	8.7
Str→May	*-.051	*-.372	*-.146	*-.124	-.383	.002	-.005	-.010	-.013	-.009	-.003	25.4
Str→July	*-.106	-.032	.001	.017	-.084	*.006	*.005	.003	.001	.001	.001	6.7
Str→Aug	-.031	.101	*.174	*.118	.045	*.008	*.006	.001	-.001	-.001	-.001	13.4
Str→Sept	*.110	.051	.053	-.094	-.067	*.015	*.011	*.006	.004	.001	-.001	19.3
Str→Oct	.136	.010	.074	.011	*-.172	*.017	*.010	.003	.001	-.003	-.002	21.8
Str→Dec	*.158	-.016	.044	-.064	-.081	*5.200	*.008	.004	.002	-.001	-.003	16.4

[1] L_6 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.15

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1984 Soyoil Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	*-.618	*-.417	*-.307	*-.182	-.086	*4.300	*3.260	.635	.680	-.403	26.5
Mar→Str	*-.587	*-.392	*-.270	*-.177	*-.110	*4.720	.973	1.050	.809	-.629	23.3
May→Str	*-.500	*-.285	*-.183	-.107	-.069	*4.760	.057	1.490	.340	.539	18.0
July→Str	*-.369	*-.154	-.048	-.015	-.024	*3.930	.284	.565	.563	.839	10.7
Aug→Str	*-.256	-.062	.008	.020	.012	*2.990	-.218	.777	.539	.881	6.1
Sept→Str	*-.249	-.042	.021	.019	.030	*3.450	-.833	.324	1.390	.614	6.7
Oct→Str	*-.260	-.050	.033	.051	.053	*4.350	-.687	.695	.699	.357	7.7
Dec→Str	*-.244	-.048	.043	.071	.061	*3.680	-.943	.995	-.384	.307	7.3
Str→Jan	*.192	.026	.001	-.033	-.096	-.001	-.002	-.001	-.003	-.002	5.7
Str→Mar	*.183	-.010	-.019	-.013	-.078	-.002	.001	-.001	-.004	-.003	5.2
Str→May	*.190	-.082	.048	-.046	-.088	-.000	*.006	.001	-.001	-.000	6.5
Str→July	*.155	-.095	-.052	.038	.005	-.001	.005	.004	.003	-.000	3.7
Str→Aug	*.134	-.070	.026	.015	.001	-.000	.004	.001	-.001	-.002	2.7
Str→Sept	*.158	*-.155	.012	-.033	-.023	-.001	*.005	.002	-.001	-.000	4.8
Str→Oct	*.142	-.042	-.066	-.062	.016	-.001	.002	.001	-.001	-.000	3.4
Str→Dec	.054	-.043	-.031	-.024	-.034	-.000	.000	-.000	-.002	-.000	1.1

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.16

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1984 Soyoil Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	*-.613	*-.407	*-.298	*-.166	-.073	*6.180	*3.110	*3.100	.629	.887	.190	33.8
Mar→Str	*-.573	*-.403	*-.263	*-.146	-.089	*7.750	*3.300	1.050	1.190	.913	-.028	35.9
May→Str	*-.499	*-.338	*-.192	-.095	-.067	*8.340	*3.170	.739	1.090	.727	1.280	32.1
July→Str	*-.364	*-.199	-.078	-.018	-.021	*8.010	*2.690	1.050	.979	.255	.798	26.8
Aug→Str	*-.253	-.096	.002	.031	.026	*7.920	1.930	.342	.568	.423	.874	19.6
Sept→Str	*-.243	-.078	.005	.027	.030	*7.310	*2.290	.304	.235	1.630	.786	16.8
Oct→Str	*-.255	-.062	.024	.058	.054	*6.450	*3.430	-.415	1.120	1.100	.255	14.3
Dec→Str	*-.243	-.051	.045	.084	.063	*5.950	*3.360	-.689	1.180	-.242	.511	12.9
Str→Jan	*.123	-.026	-.009	-.044	-.089	*.016	*.009	.005	.003	.000	-.001	15.1
Str→Mar	.084	-.031	-.041	-.031	-.064	*.021	*.011	*.010	.005	-.000	-.000	20.7
Str→May	.092	-.083	.017	-.053	*-.099	*.020	*.010	*.012	.005	.001	.001	22.6
Str→July	.066	*-.101	-.064	.026	-.014	*.023	*.008	*.009	.005	.001	.000	21.1
Str→Aug	.080	-.067	.012	.005	-.015	*.018	.004	*.005	.001	-.002	-.002	16.7
Str→Sept	*.107	*-.143	.007	-.053	-.033	*.015	.003	*.006	.002	-.001	-.000	15.1
Str→Oct	.094	-.035	-.074	-.070	.118	*.110	.002	.002	.001	-.002	-.001	10.2
Str→Dec	.016	-.033	-.041	-.020	-.037	*.012	.002	.001	-.001	-.003	-.001	7.1

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.17

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1985 Soyoil Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str	[2]•-.203	-.052	.069	.087	.059	•3.660	-1.850	1.780	-1.370	.841	7.4
Mar→Str	•.281	-.065	•.142	-.054	•.187	-.481	.885	-.179	-.011	.038	12.4
May→Str	•.334	-.045	.033	.054	.061	-.233	.019	.714	-1.160	.549	12.5
July→Str	•.300	-.007	.081	-.081	.044	-.489	-.393	.213	-.602	.068	9.6
Aug→Str	•.322	-.009	.072	•-.119	•.131	-.663	-1.040	.844	-.267	-.359	13.0
Sept→Str	-.066	-.006	-.090	.049	•-.125	.477	-.203	1.160	.210	.813	3.1
Oct→Str	-.305	.008	-.096	.044	•-.126	.282	-.589	1.070	.257	.152	3.0
Dec→Str	-.022	-.017	-.093	.041	•-.119	-.130	.007	1.070	-.168	.406	2.2
Str→Jan	.043	-.016	-.043	-.039	-.037	-.001	.001	-.001	-.002	-.000	1.3
Str→Mar	.016	.010	-.049	-.021	-.073	-.004	.007	-.003	-.002	-.000	2.4
Str→May	.054	-.103	.006	.023	-.061	•-.009	.006	-.002	-.003	-.003	2.9
Str→July	.064	-.092	-.033	.052	•-.104	•-.009	.006	.000	-.007	-.002	3.8
Str→Aug	.048	-.052	-.081	.075	-.061	-.007	.006	•.015	•-.143	-.010	6.2
Str→Sept	-.013	-.101	-.080	.082	.046	-.004	•.012	.007	•-.010	-.009	6.2
Str→Oct	-.052	•-.135	-.101	.069	-.017	-.003	•.013	.007	-.005	-.002	5.5
Str→Dec	-.054	•-.122	-.077	.074	.025	-.000	•.011	•.010	-.004	-.001	4.8

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.18

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1985 Soyoil Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	*-.198	-.062	.075	.098	.061	*6.740	*3.370	-1.740	2.070	-1.110	1.090	13.5
Mar→Str	*.307	-.103	*.157	-.039	*.188	*5.700	-.575	.829	.099	.111	.457	25.0
May→Str	*.382	-.077	.042	.070	-.075	*5.310	-.517	.565	.680	-1.280	-.874	27.5
July→Str	*.345	-.040	.081	-.043	.053	*5.300	-.831	.093	.387	-.881	.619	25.7
Aug→Str	*.363	-.030	.076	-.071	*.141	*4.170	-.770	-.665	.931	-.479	.101	23.8
Sept→Str	-.045	-.071	*-.126	.101	-.080	*5.280	.543	.333	*1.590	-.225	.568	20.5
Oct→Str	-.021	-.062	*-.133	.069	*-.114	*5.270	.556	.123	*1.600	-.107	.241	18.9
Dec→Str	-.020	-.080	*-.152	.061	*-.113	*5.610	.176	.693	*1.500	-.582	.263	19.5
Str→Jan	.007	.002	-.060	-.026	-.046	*.010	.001	.002	-.001	-.003	-.001	7.8
Str→Mar	.029	-.013	-.044	-.021	-.074	*.025	*-.011	.008	-.006	-.001	-.005	16.4
Str→May	.061	*-.103	-.017	.060	-.079	*.323	*-.020	.007	-.003	-.005	-.005	19.6
Str→July	.081	-.079	-.040	.073	*-.106	*.033	*-.019	.007	-.003	-.004	-.003	20.9
Str→Aug	.059	-.047	-.079	.051	-.077	*.043	*-.013	.009	.010	-.009	-.007	22.1
Str→Sept	-.029	-.095	*-.119	.075	.019	*.034	-.002	*.012	.010	*-.011	-.004	23.1
Str→Oct	-.061	*-.117	*-.135	.061	-.022	*.031	-.002	*.013	*.010	-.006	.002	21.0
Str→Dec	-.050	*-.122	*-.110	.079	.013	*.031	.000	.011	.013	-.005	.003	21.7

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.19

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1986 Soyoil Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	-.055	.003	-.101	.023	•-.140	.335	-.475	1.040	.727	.586	3.5
Mar→Str	-.057	-.003	-.110	.023	•-.143	.864	-.375	.749	.690	.450	3.7
May→Str	-.042	-.047	•-.143	.004	•-.149	.386	-.507	.765	.970	.833	4.2
July→Str	•-.143	-.088	•-.177	.023	-.064	.516	-.333	1.290	.615	-.040	5.3
Aug→Str	•-.139	-.084	•-.114	-.020	-.057	-.137	.220	-.207	•1.350	.391	6.0
Sept→Str	-.102	-.052	•-.199	.026	-.092	-.151	-1.050	•1.840	.396	.638	6.3
Oct→Str	•.174	-.101	-.087	•.205	-.078	•-2.260	-.629	1.340	•2.670	1.060	10.6
Dec→Str	•.170	-.113	-.096	•-.237	.002	•-2.580	-.268	1.360	•3.070	.153	10.1
Str→Jan	.023	-.052	-.061	•.151	.019	.006	•.009	•.010	-.006	-.001	4.9
Str→Mar	-.047	-.077	.015	•.139	.078	-.002	•.011	.007	-.003	-.003	5.3
Str→May	-.068	-.082	.045	.097	.086	-.000	.002	.000	-.002	-.003	2.4
Str→July	-.046	-.054	.060	.086	.071	-.002	-.001	-.004	-.004	-.001	1.8
Str→Aug	•-.477	•-.202	-.012	.096	.059	.018	.004	-.004	-.001	-.002	18.7
Str→Sept	-.053	-.059	.098	.034	.047	.003	-.002	-.006	.005	-.001	2.1
Str→Oct	.038	-.061	.097	.035	•.127	.004	-.000	-.007	.002	-.006	2.5
Str→Dec	•-.128	.040	.069	.039	.019	•.011	-.010	-.005	-.004	-.002	2.9

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.20

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1986 Soyoil Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	-.026	-.052	*-.159	.059	*-.138	*5.900	.201	-.170	1.400	-.164	.473	21:9
Mar→Str	-.043	-.064	*-.147	.037	*-.125	*5.500	1.120	.050	.664	-.077	.022	20.4
May→Str	-.042	-.058	*-.143	.021	*-.127	*6.790	.850	.049	.456	.311	.251	28.0
July→Str	*-.132	-.079	*-.149	.053	-.056	*7.150	.847	.056	.861	.003	-.551	30.9
Aug→Str	*-.188	-.095	*-.102	-.017	-.050	*2.700	*1.150	.765	-.174	*1.090	.231	13.4
Sept→Str	*-.123	-.037	*-.154	.061	-.082	*7.370	.237	-.619	1.120	.147	.293	30.7
Oct→Str	*.147	-.098	-.037	*-.219	-.030	*7.410	*1.970	-.177	.616	*2.930	.122	42.7
Dec→Str	.087	-.044	-.059	*-.207	.016	*7.460	*-1.620	-.564	.841	*2.780	.013	44.7
Str→Jan	.012	-.036	-.094	*.128	.000	*.032	-.003	*.009	*.013	-.007	.004	22.9
Str→Mar	-.074	-.065	-.008	*.117	.064	*.031	-.001	*.011	*.010	-.003	.001	21.7
Str→May	-.082	-.063	.017	.061	.055	*.037	.001	.003	.005	-.003	.002	26.6
Str→July	-.066	-.042	.010	.062	.073	*.038	.004	.002	.003	-.005	.001	28.4
Str→Aug	*-.474	*-.208	-.006	.057	.048	*.029	*.022	.006	-.001	-.000	-.001	25.1
Str→Sept	-.047	-.021	.033	.020	.024	*.035	.006	-.000	.001	-.005	.002	27.6
Str→Oct	.714	-.030	.032	*-.165	.075	*.048	-.005	.004	-.002	*.012	-.003	37.5
Str→Dec	.005	.054	-.001	*-.119	.011	*.052	.002	-.003	.000	*.008	-.002	40.2

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.21

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1983 Soymeal Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	*-.678	*-.496	*-.363	*-.238	*-.114	*.849	.185	.175	.170	-.028	31.2
Mar→Str	*-.668	*-.485	*-.353	*-.215	*-.106	*.728	.262	.139	.036	-.007	30.3
May→Str	*-.664	*-.481	*-.351	*-.208	-.100	*.657	.195	.196	.001	-.067	30.3
July→Str	*-.646	*-.459	*-.336	*-.204	*-.100	*.577	.276	.172	.097	.081	28.9
Aug→Str	*-.664	*-.499	*-.378	*-.239	*-.122	*.554	*.448	.311	.151	.088	29.9
Sept→Str	*-.606	*-.418	*-.291	*-.163	-.093	*.151	*.359	.236	-.051	.041	25.7
Oct→Str	*-.602	*-.404	*-.282	*-.157	-.076	*.418	*.315	.223	.022	-.064	26.4
Dec→Str	*-.609	*-.385	*-.284	*-.155	-.079	*.435	*.407	*.335	.059	-.050	27.0
Str→Jan	-.028	.034	.087	-.079	-.041	.011	.002	.021	.012	.009	2.0
Str→Mar	-.047	.031	.007	-.073	-.039	.015	.008	.015	.016	.010	1.5
Str→May	.001	-.013	.044	-.001	-.019	.012	.004	.011	.016	.009	0.9
Str→July	-.053	.031	-.023	.005	-.002	.012	.003	.013	.013	.010	0.9
Str→Aug	.063	*.114	.032	-.042	.008	.012	.000	.016	.025	.014	3.0
Str→Sept	*.125	.008	-.066	-.100	*-.119	-.021	-.038	-.038	-.023	-.017	7.4
Str→Oct	.055	.013	-.076	*-.133	*-.141	-.038	*-.055	-.021	-.029	-.024	8.5
Str→Dec	.008	.006	-.029	*-.129	*-.110	-.027	-.031	-.025	-.029	-.025	5.2

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

* t-test: .05 level of significance.

Table A.22

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1983 Soymeal Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.691	•-.498	•-.387	•-.252	•-.124	•1.130	•.881	.146	.166	.260	.019	35.1
Mar→Str	•-.684	•-.494	•-.369	•-.232	•-.116	•1.070	•.778	.229	.132	.114	.035	34.2
May→Str	•-.674	•-.485	•-.361	•-.221	•-.108	•.883	•.656	.206	.157	.002	-.050	33.3
July→Str	•-.657	•-.461	•-.347	•-.215	•-.108	•.872	•.624	.249	.192	.092	.082	32.6
Aug→Str	•-.674	•-.499	•-.392	•-.260	•-.134	•.851	•.501	•.351	.283	.186	.081	34.5
Sept→Str	•-.592	•-.393	•-.267	•-.149	-.082	•.647	•.434	•.354	.278	.013	.118	29.9
Oct→Str	•-.580	•-.372	•-.270	•-.140	-.062	•.596	•.385	•.307	•.268	.101	.020	26.4
Dec→Str	•-.609	•-.385	•-.284	•-.155	-.079	•.571	•.435	.402	•.335	.059	-.050	31.1
Str→Jan	-.071	.025	-.000	-.088	-.039	•.051	•.045	.027	•.040	.024	.014	7.7
Str→Mar	-.085	.017	-.001	-.075	-.039	•.052	•.050	•.033	•.034	.027	.015	7.0
Str→May	-.031	-.022	.035	-.001	-.016	•.048	•.043	.028	.028	.026	.013	5.1
Str→July	-.087	.015	-.034	-.000	-.007	•.059	•.050	.030	•.033	.025	.015	6.0
Str→Aug	.020	.080	.008	.053	.001	•.077	•.063	.038	• 045	• 043	.023	9.3
Str→Sept	.080	-.024	-.086	-.096	•-.123	•.087	.032	-.002	-.012	-.008	-.009	12.6
Str→Oct	.015	-.017	-.097	•-.135	•-.134	•.097	.021	-.016	.006	-.013	-.017	13.8
Str→Dec	-.035	-.033	-.062	•-.135	-.105	•.098	.033	.007	.002	-.013	-.017	10.5

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.23

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1984 Soymeal Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.573	•-.343	•-.243	-.113	-.044	•.397	•.318	.215	.006	-.081	24.5
Mar→Str	•-.474	•-.331	•-.233	•-.147	•-.086	•.438	.036	•.287	.204	-.076	20.5
May→Str	•-.444	•-.219	•-.122	-.059	-.027	•.508	-.078	.235	.111	-.105	17.4
July→Str	•-.336	•-.126	-.026	.011	.017	•.556	.025	.131	.159	-.030	10.7
Aug→Str	•-.253	-.065	.015	.037	.056	•.470	.088	.187	.158	-.116	6.8
Sept→Str	•-.254	-.072	.036	.055	.069	•.555	.303	.110	.148	-.248	7.3
Oct→Str	•-.242	-.061	.052	.075	.078	.362	.361	.201	.094	-.310	7.0
Dec→Str	•-.245	-.056	.053	.091	.080	•.439	.376	.309	-.128	-.323	7.4
Str→Jan	.006	.032	-.017	•-.142	-.100	-.036	-.037	-.029	-.021	-.013	4.9
Str→Mar	.011	.028	-.007	•-.122	-.070	•-.040	•-.045	-.037	-.020	-.018	4.4
Str→May	.023	-.026	-.015	•-.108	-.078	-.031	-.025	-.022	-.019	-.027	4.1
Str→July	-.015	-.025	-.052	•-.105	-.081	-.010	.002	-.002	-.003	-.020	2.8
Str→Aug	•-.106	.025	-.067	•-.176	•-.141	.003	-.003	.001	-.003	-.014	6.2
Str→Sept	•-.118	-.021	-.084	-.090	•-.137	-.005	.001	.002	-.007	-.127	4.7
Str→Oct	•-.138	.013	•-.103	-.071	-.093	-.013	-.008	-.002	-.006	-.005	5.2
Str→Dec	•-.137	.008	•-.125	•-.112	-.043	-.011	-.015	-.003	-.000	-.010	5.5

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.24

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1984 Soymeal Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.553	•-.322	•-.226	-.101	-.037	•.567	•.393	•.300	.224	.086	-.024	28.7
Mar→Str	•-.442	•-.295	•-.204	•-.131	-.072	•.791	•.430	.014	•.292	•.300	-.021	28.3
May→Str	•-.419	•-.199	-.105	-.044	-.005	•.805	•.489	-.057	.247	.198	-.043	24.4
July→Str	•-.327	•-.127	-.025	.014	.030	•.825	•.569	.047	.179	.256	.045	19.8
Aug→Str	•-.257	-.061	.136	.040	.072	•1.110	•.589	.060	.263	•.355	.041	18.4
Sept→Str	•-.249	-.073	.033	.062	.082	•1.110	•.685	.327	.203	.248	-.096	15.9
Oct→Str	•-.230	-.053	.054	.081	.083	•.935	•.491	.349	.297	.160	-.223	11.2
Dec→Str	•-.235	-.041	.056	.091	.090	•.986	•.574	.369	•.432	-.017	-.280	12.7
Str→Jan	-.033	.001	-.038	•-.142	-.092	•.098	.021	-.004	-.005	-.010	-.009	10.2
Str→Mar	-.044	.023	-.043	•-.147	-.061	•.125	.019	-.004	-.008	-.002	-.008	13.9
Str→May	-.030	-.018	-.040	•-.119	-.067	•.105	.016	-.002	-.009	-.139	-.024	12.2
Str→July	-.076	-.027	-.067	•-.122	-.078	•.110	.027	.015	.001	-.004	-.021	12.7
Str→Aug	•-.159	.015	-.089	•-.194	•-.128	•.111	•.032	.004	-.001	-.007	-.002	17.9
Str→Sept	•-.164	-.046	-.093	•-.103	•-.117	•.083	.016	.007	-.001	-.011	-.017	13.5
Str→Oct	•-.156	-.005	•-.113	-.075	-.078	•.485	-.001	-.005	-.005	-.010	-.009	9.5
Str→Dec	•-.159	-.011	•-.140	•-.105	-.026	•.051	.002	-.012	-.005	-.005	-.014	10.2

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.25

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1985 Soymeal Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.247	-.068	.068	.097	.090	.283	•.517	.230	-.207	•-.650	8.3
Mar→Str	•-.212	-.068	.089	•.107	•.097	.249	.521	.301	•-.584	•-.761	8.3
May→Str	•.248	-.049	•.148	-.015	•.172	.133	.068	-.300	•-.389	•-.369	14.3
July→Str	•.274	-.051	•.167	•-.114	•.118	.170	.019	-.253	-.148	-.095	12.4
Aug→Str	.107	-.034	.081	•-.126	-.022	.199	-.195	•-.276	•.262	-.073	6.0
Sept→Str	-.078	.006	-.026	.045	-.099	•.298	.025	-.163	.041	-.079	3.5
Oct→Str	-.056	-.000	-.041	.045	•-.121	•.346	.010	-.139	-.006	-.150	4.2
Dec→Str	-.056	.008	-.054	.033	•-.104	•.318	-.122	-.058	.023	-.057	3.1
Str→Jan	-.051	-.038	•-.102	-.013	•-.114	-.006	-.007	.006	.007	-.003	3.2
Str→Mar	-.065	.011	-.076	-.046	-.077	-.004	-.015	.004	.010	.006	2.7
Str→May	-.005	.001	•-.119	-.087	-.065	•-.031	.006	.009	.001	.009	3.4
Str→July	-.002	.085	•-.109	.037	.035	-.028	-.033	.029	-.011	-.001	3.4
Str→Aug	.026	.094	-.083	-.030	.044	-.039	-.021	.025	•.048	.017	4.1
Str→Sept	-.002	.039	•-.110	-.002	.060	-.029	-.004	.030	•.052	.020	4.8
Str→Oct	.004	.048	-.053	.037	.055	-.021	-.005	.012	.038	.009	2.6
Str→Dec	.088	-.002	-.063	.026	.035	-.027	.000	.010	•.042	-.006	3.1

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.26

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1985 Soymeal Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	•-.240	-.059	.060	.088	•.094	•1.240	.346	•.563	.356	-.192	-.509	13.1
Mar→Str	•-.208	-.052	.085	•.097	.091	•1.060	.318	.509	.382	-.535	•-.679	11.5
May→Str	•.276	-.054	•.140	-.015	•.164	•.906	.138	.068	-.192	-.310	-.311	20.0
July→Str	•.300	-.020	•.141	•-.105	•.118	•.936	.172	.061	-.151	-.182	-.127	22.6
Aug→Str	•.135	-.018	.063	•-.161	-.034	•.717	.180	•-.263	-.216	•.284	-.104	14.9
Sept→Str	-.063	.008	-.042	.019	•-.109	•.520	•.299	-.045	-.106	.042	-.110	7.3
Oct→Str	-.045	.002	-.047	.028	•-.126	•.487	•.344	-.013	-.113	.023	-.177	7.5
Dec→Str	-.040	.008	-.060	.008	•-.100	•.600	•.266	-.121	-.021	.006	-.079	8.3
Str→Jan	-.063	-.059	•-.111	-.004	-.087	•.041	.005	-.005	.003	.003	-.007	8.2
Str→Mar	-.073	-.006	-.086	-.027	-.052	•.033	.003	-.013	.001	.006	.003	6.2
Str→May	-.014	-.004	-.097	-.059	-.038	•.073	•-.049	.010	-.001	.002	-.003	9.8
Str→July	-.024	.083	-.078	.055	.046	•.125	•-.062	-.026	.008	.004	-.015	14.7
Str→Aug	-.000	•.119	-.047	-.065	.053	•.132	•-.053	-.017	.014	•.065	.020	13.1
Str→Sept	-.024	.041	-.097	-.005	.066	•.075	-.023	-.004	.032	•.049	.027	8.5
Str→Oct	-.020	.047	-.043	.037	.066	•.017	-.017	-.005	.015	.034	.017	6.0
Str→Dec	.060	.008	-.058	.024	.040	•.089	-.022	-.002	.015	•.039	.003	8.2

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.27

Regression Results from Bivariate Causality Tests for Temporal Relationships Between 1986 Soymeal Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	-.074	.005	-.060	.040	•-.129	•.378	-.164	-.054	.028	-.039	5.0
Mar→Str	-.058	.011	-.071	.051	•-.119	.214	-.185	.003	-.006	-.051	3.8
May→Str	-.049	.055	•-.130	.041	•-.117	.102	-.185	.074	-.057	-.094	4.8
July→Str	-.033	-.050	•-.110	.034	•-.115	.014	-.131	.051	-.062	-.098	3.6
Aug→Str	-.105	-.080	•-.187	.079	-.066	-.065	-.091	.144	-.239	-.006	6.7
Sept→Str	•-.106	-.062	•-.171	.060	-.063	.392	-.148	-.013	•-.304	-.011	6.8
Oct→Str	•.150	•-.143	-.077	-.071	-.014	•-.332	-.094	.086	-.080	-.016	7.0
Dec→Str	.095	•-.119	-.101	-.063	.033	-.183	-.085	•.227	-.058	-.108	5.4
Str→Jan	.082	-.030	-.064	.006	.052	-.005	.001	.008	.031	.000	2.1
Str→Mar	.003	-.014	-.052	-.001	.017	-.017	.017	-.012	.024	.025	1.4
Str→May	-.051	-.016	.045	-.035	.017	.013	-.004	.001	.034	.006	1.2
Str→July	-.065	-.022	.029	-.009	.055	.027	-.002	.001	.032	-.002	1.5
Str→Aug	•-.146	.067	.066	-.028	-.059	.004	-.029	.004	.029	-.009	4.0
Str→Sept	-.059	-.063	.082	-.040	.078	.005	-.007	.093	.019	.002	2.5
Str→Oct	-.037	-.020	.147	-.022	-.028	.011	-.037	.005	.003	-.014	3.9
Str→Dec	-.040	-.022	.065	-.076	.029	.001	-.039	.017	.029	-.054	3.8

[1] The first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Table A.28

Regression Results from Bivariate Causality Tests for Contemporaneous Relationships Between 1986 Soymeal Futures Prices and AWP Street Prices[1]

	L_1	L_2	L_3	L_4	L_5	L_0	IL_1	IL_2	IL_3	IL_4	IL_5	R^2
Jan→Str[2]	-.071	.005	-.065	.022	•-.129	•.600	•.329	-.145	-.016	.023	-.071	10.8
Mar→Str	-.048	.002	-.065	.037	•-.133	•.561	.212	-.178	.033	-.005	-.060	9.7
May→Str	-.058	-.052	•-.131	.017	•-.121	•.701	.138	-.174	.042	-.032	-.106	12.2
July→Str	-.053	-.048	•-.111	.010	•-.114	•.759	.064	-.115	.029	-.056	-.140	13.5
Aug→Str	•-.108	-.054	•-.190	.053	-.058	•.888	.065	-.150	.085	-.215	.047	18.9
Sept→Str	•-.110	-.056	•-.179	.043	-.064	•.852	.089	-.094	-.083	-.270	-.077	18.7
Oct→Str	•.140	•-.109	-.082	-.074	-.001	•.915	•-.297	-.075	-.048	-.059	.009	23.3
Dec→Str	-.095	-.087	•-.116	-.088	.079	•.837	-.150	-.066	.173	.006	-.133	20.0
Str→Jan	.044	-.014	-.059	.004	.056	•.101	.003	.000	.014	.026	.013	8.0
Str→Mar	-.020	.007	-.053	.000	.023	•.109	-.011	.016	-.004	.018	.038	7.4
Str→May	-.063	.005	.037	-.028	.027	•.113	.019	.002	.016	.029	.029	9.1
Str→July	-.067	-.005	.022	-.001	.068	.129	.031	.004	.016	.028	.013	11.1
Str→Aug	•-.137	.081	.044	.008	-.058	•.148	.019	-.017	.032	.017	.001	16.7
Str→Sept	-.065	-.041	.084	.006	.079	•.149	.021	.002	.035	.010	.011	15.0
Str→Oct	-.026	-.002	•.131	-.007	-.025	•.191	-.017	-.009	.020	.016	-.011	20.7
Str→Dec	-.006	.006	.023	.065	-.049	•.184	-.017	-.017	.036	.041	-.061	18.6

[1] L_0 represents the variable to test for contemporaneous relationships; the first five coefficients represent the lagged dependent variables; the last five coefficients represent the lagged independent variables.

[2] A→B is the notation representing Geweke lead-lag equations testing the significance of the relationship in which price series A leads price series B. A.W.P. canola street prices are represented by the notation Str, while the futures contract price series is noted as the abbreviated form of the contract expiry month.

• t-test: .05 level of significance.

Appendix B: Data Description and Sources

Agricultural price data used in the preceeding analysis were obtained from three sources, Alberta Wheet Pool daily price series for canola; the Chicago Board of Trade Commodity Futures Data Tapes; and the I. P. Sharp Associates Ltd. AGDATA tape. Daily data series used in the analysis were collected for the time period from January 4, 1982 to December 31, 1986.

Alberta Wheet Pool street prices for No. 1 Canadian canola were obtained from the Statistics Branch of Alberta Agriculture. this price series is quoted in Canadian dollars.

Daily closing prices for soybean, oil and meal futures contract prices were obtained from the Chicago Board of Trade Commodity Futures Data Tape. The tape contains daily data for the open, high, low and closing futures prices, volume of sales and open interest for each commodities contract traded. Prices from this data source were quoted in American dollars.

The daily closing price quotes for No. 1 Canadian rapeseed contracts sold on the Winnipeg Commodity Exchange were collected from the I. P. Sharp Associates Ltd. AGDATA tape. Winnipeg Commodity Exchange futures contract prices for rapeseed are based on Vancouver delivery, and are quoted in Canadian dollars.